

MAG REGIONAL TRANSPORTATION PLAN

Phase 1

Analysis of Alternative Growth Concepts

Draft Task Report

*Mobility for the
New Millennium*

February 2003



**MARICOPA
ASSOCIATION of
GOVERNMENTS**

Regional Transportation Plan – Phase 1

Task Report

ANALYSIS OF ALTERNATIVE GROWTH CONCEPTS

Prepared for:



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PREFACE

This document is one of a series of reports and documents that have been prepared for the MAG Regional Transportation Plan – Phase 1 project. There are five published documents that were produced as final products of specific tasks. These five documents form the basis of the **Summary Report**. The five task reports are:

**Status of Regional Transportation
Values, Goals and Objectives
Alternative Growth Concepts
Analysis of Alternative Growth Concepts
Transportation Planning Principles**

In addition to the above documents, several other products from RTP Phase 1 are available in the project files. These products provide documentation of the major steps taken in the project and provide input to the five documents listed above and the final report.

❑ **Issue Papers :**

- Demographics and Social Change
 - New Economy
 - Environmental and Resource
 - Land Use and Urban Development
 - Transportation Modes and Technologies
- ❑ Five forums were held in February and March 2001 with presentations by nationally recognized experts in the five categories listed above under Issue Papers. **Videos** were made of most of the forums, and a presentation was prepared identifying the major themes of the forums.
- ❑ Sixteen focus group meetings were held in May and June 2001. The groups included various geographic, ethnic and agency orientations. A summary is provided in the **Focus Groups Results** task paper dated August 2001.
- ❑ Interviews were held with 21 resource and agency stakeholders throughout the metropolitan area. The findings from these interviews were documented in a task paper dated October 2001.
- ❑ The **Population Projections** task paper dated September 19, 2001, was prepared to provide the “horizon” projections to be used in the analyses for this RTP.
- ❑ A task paper entitled **Summary of Research and Transportation Model Adjustments for Vehicle Trip Reductions** dated March 27, 2002, was prepared to assist in determining potential traffic impacts of trip reduction actions.

1.0 INTRODUCTION

This task report consists of three chapters following this introductory chapter. Chapter 2 presents a comparison of transportation-related statistics for Phoenix and 16 other large urban areas. These data were primarily derived from the Texas Transportation Institute (TTI) Mobility Data. The data represent the relative condition in these large urban areas in 2000. It is believed that these data provide a valid comparison among urban areas; however, the data are from a different source and cannot be compared to data produced by MAG for use in Chapter 3 and 4 or to the Status of the Regional Transportation System Task Report.

The third chapter presents a comparison of the four growth concepts that were developed and presented in the Alternative Growth Concepts Task Report. These four growth concepts are Base Case, Infill, Activity Centers, and Suburban. The comparison provided in Chapter 3 is based upon travel forecasts produced by MAG for the Phoenix greater metropolitan area when it reaches a population of 9.2 million. The metropolitan area is expected to encompass portions of northern Pinal County. This population level is expected to occur in 2050 or beyond. Chapters 3 and 4 are based on somewhat different regional boundaries and socioeconomic forecasts than those used in the previous Status of the Regional Transportation System Report. Also, in these two chapters, congestion is defined as Level of Service F—i.e., a volume to capacity ratio greater than 1.00. In contrast, the comparative data in Chapter 2 are based on a broader definition of congestion developed by TTI.

The comparative analysis of the four growth concepts was based upon a constant transportation system. This system consists of the planned roadway and transit system included in the MAG Long Range Transportation Plan plus additional roadways and bus transit systems extended to the expanded metropolitan area. Although some differences in the future transportation system would occur with the different growth concepts, the project team does not believe these differences are large because there are few opportunities to make large changes within the existing developed portion of the urban area. Accordingly, the comparisons made among the growth scenarios based on this limited analysis may be useful in helping the region to gain insights regarding growth in the future.

Chapter 4 presents observations regarding future transportation system needs in the greater Phoenix Metropolitan Area. These observations are based upon a more subjective analysis of the travel forecasts developed by the MAG staff. These analyses are intended to help establish a basic direction for the future transportation system. The specifics of that system will be defined in Phase 2 of the Regional Transportation Plan.

2.0 COMPARISON OF MAG AREA IN 2000 WITH OTHER URBAN AREAS

When trying to understand the long-term needs of a metropolitan area, it is helpful to view that area against a backdrop of other metropolitan areas. Ongoing studies by TTI provide a wealth of data with which to make such comparisons. In this chapter, the MAG area is compared to 16 other urban areas in the United States. This comparison is intended to aid the reader in understanding how the MAG area transportation system functions in comparison with these other areas. This comparison also sheds some light on how to view the long-term future of the MAG area and its projected transportation system, as discussed in Chapters 3 and 4.

2.1 Methodology and Data Sources

The TTI recently completed the *2002 Urban Mobility Report* and made it available on its web site. This report appears to contain the most comprehensive comparative data available* on the largest urban areas in the United States. The data are based on 2000 statistics for the urbanized areas in each of the major metropolitan areas. Since the primary purpose of this analysis is to compare the future MAG area to other large metro areas, it was decided to focus on metro areas larger than greater Phoenix urbanized area in 2000. It was also decided to exclude the New York City area from the analyses because its central core density and transportation system differ so dramatically from all other urban areas in the United States. The final selection of urban areas to compare included all areas with a 2000 population of 2 million or more. A total of 17 urban areas, as listed in Table 2.1, were used in the comparisons. In the TTI analysis, data were assembled based on census definitions of urbanized areas. These data are labeled Phoenix area, but include other MAG jurisdictions covered by the census urbanized area boundary.

Except for the transit information, all data were derived from the TTI *2002 Mobility Report* and the supporting Mobility Data for each of the metropolitan areas. The specific tables of the data sources are noted with each table in this chapter. In some cases, the tables contain data that were calculated directly from the TTI data displayed in the tables. Where appropriate, the list of urban areas was sorted to highlight the relative ranking of the urban areas. The transit data were obtained from the Federal Transit Administration (FTA).

The observations and conclusions in this chapter are those of the URS team and were not extracted from the TTI reports.

2.2 Population and Density Comparisons

Presented in Table 2.1 are the basic data on population, area in square miles, and miles of roads in the system for each of the 17 urban areas. The urban areas are listed in descending order of population. Los Angeles, with over 12 million population, is by far the largest of the urban areas included in this study and is exceeded only by New York City, which was not included in the list due to the unique character of the area. Chicago is the next largest urban area with over 8 million population. All the other urban areas range between 4.6 million and 2.0 million. Phoenix is the 12th largest urban area with 2.6 million.

* The authors believe the data to be relatively comparable from area to area but do not have the basis for determining the accuracy of the data presented by TTI. The TTI data are not directly comparable to the MAG data presented in the subsequent chapters.

Table 2.1
Comparison of Phoenix to Peer and Larger Urban Areas – 2000 Urbanized Area
Basic Data

| Sorted by Population | 2000 Population (1000s) | 2000 Urban Area (Sq Mi) | Freeways | | Principal Arterial | | Roadway System | |
|--------------------------|----------------------------|----------------------------|----------------------------|---------------|----------------------------|---------------|----------------------------|---------------|
| | | | Lane Miles | VMT* | Lane Miles | VMT* | Centerline Miles | VMT* |
| Los Angeles | 12,680 | 2,265 | 5,400 | 126,495 | 10,950 | 72,500 | 26,950 | 275,000 |
| Chicago-NE IL | 8,090 | 2,775 | 2,665 | 36,225 | 4,500 | 30,450 | 19,310 | 123,470 |
| Philadelphia | 4,590 | 1,385 | 1,740 | 25,445 | 3,035 | 21,325 | 13,415 | 77,500 |
| San Francisco | 4,030 | 1,255 | 2,335 | 47,980 | 2,150 | 15,150 | 9,350 | 85,500 |
| Detroit | 4,025 | 1,315 | 1,815 | 31,125 | 4,370 | 29,415 | 13,810 | 89,500 |
| Dallas-Fort Worth | 3,800 | 1,920 | 3,150 | 48,700 | 4,120 | 24,200 | 18,500 | 112,000 |
| Washington DC | 3,560 | 1,030 | 1,885 | 34,535 | 2,410 | 20,060 | 10,330 | 83,000 |
| Houston | 3,375 | 1,740 | 2,475 | 37,900 | 2,810 | 16,470 | 15,550 | 96,000 |
| Boston | 3,025 | 1,160 | 1,305 | 22,500 | 2,060 | 16,600 | 10,135 | 59,540 |
| Atlanta | 2,975 | 1,815 | 2,315 | 42,940 | 2,245 | 16,165 | 13,145 | 101,500 |
| San Diego | 2,710 | 755 | 1,795 | 33,745 | 1,830 | 11,090 | 5,965 | 58,000 |
| Phoenix | 2,600 | 1,120 | 1,030 | 19,425 | 3,065 | 18,025 | 10,230 | 55,000 |
| Minn/St. Paul | 2,475 | 1,235 | 1,580 | 27,095 | 1,295 | 8,075 | 10,920 | 57,000 |
| Miami-Hialeah | 2,270 | 560 | 750 | 13,585 | 2,700 | 18,600 | 5,820 | 39,000 |
| Baltimore | 2,170 | 750 | 1,475 | 22,660 | 1,435 | 9,000 | 6,610 | 44,300 |
| St. Louis | 2,040 | 1,130 | 1,130 | 25,740 | 1,945 | 11,040 | 8,075 | 58,700 |
| Seattle | 2,000 | 875 | 1,285 | 22,455 | 1,525 | 9,100 | 7,120 | 51,000 |
| Exhibit A-1 ^a | | Exhibit A-1 ^a | Mobility Data ^b | | Mobility Data ^b | | Mobility Data ^b | |

*In thousands

^a2002 Urban Mobility Report; Schrank and Lomax, TTI, June 2002.

^bTexas Transportation Institute website <http://mobility.tamu.edu>.

Table 2.2 displays the density and percent change in population over two time frames: 1982-2000 and 1994-2000. Perhaps somewhat surprisingly, Los Angeles is the densest urban area with an average of 5,600 persons per square miles. Although historically noted for sprawl, the urban area as a whole is notably denser than second-place Miami. The densities of the central cities, as reported by Transportation Cooperative Research Program (TCRP) for 1996, show a much different picture. The older, Eastern central cities are very dense compared to the newer Western cities such as Phoenix and Los Angeles. However, these central cities have become a much smaller portion of the total urban area, so that the average densities of the urban areas are more indicative of the total transportation needs of each area. As a result, this comparison places its emphasis on the urban area density rather than the central city density.

2.3 System Size and Utilization

Phoenix urban area density is 11th out of the 17 urban areas. At 2,320 persons per square mile, the density of the Phoenix area is only 41% of the Los Angeles density. However, the Phoenix urban area density is greater than that of Seattle, Minneapolis, Dallas-Fort Worth, Houston, St. Louis, and Atlanta. Atlanta has the lowest density at 1,640 persons per square mile, or 71% of the density in Phoenix.

The percentage change in population from 1982 to 2000 and from 1994 to 2000 is also shown in Table 2.2. Atlanta was the fastest growing urban area during both periods; Phoenix was the second fastest, followed by Dallas-Fort Worth. Detroit, Boston, St. Louis, and Philadelphia were the slowest growing urban areas.

Table 2.3 provides a comparison of freeway and principal arterial lane miles per square mile of urban area and per capita. In 2000, the Phoenix area had the fewest freeway lane miles per square mile and the fourth fewest freeway and arterial lane miles per capita of the 17 urban areas analyzed. The freeway building program over the next five years probably will not move Phoenix above more than one or two other urban areas. Phoenix compares very favorably to other areas in principal arterial miles per square mile and per capita. The mile-grid of arterials has always been the backbone of the Phoenix roadway system. Only recently has the freeway system played a major role in accommodating a high percentage of vehicle miles traveled (VMT).

2.4 Congestion

Table 2.4 provides a comparison of freeway and principal arterial VMT per lane mile, the percentage of lane miles that are congested in the peak period and the daily hours of congestion. Phoenix is second only to Los Angeles and San Francisco and followed closely by San Diego in VMT per freeway lane mile. This statistic indicates that Phoenix is getting a very high utilization of its freeways. The high rate may be due to more “round-the-clock” driving and/or higher flow rates during the peak hours. The high flow rates may be due in part to the successful deployment of the freeway management system, which helps to even out peak flows and to reduce the impact of incidents. The California cities also have freeway management systems.

Los Angeles has the highest percentage of congested lane miles of freeways (85%) while Phoenix is in a tie for second (75%) with San Francisco, San Diego, and Seattle. On the other hand, Phoenix has the lowest percentage of congested lane miles of principal arterials at 50%. Phoenix falls in the middle of the number of hours of congestion with 7.6 per day. Several cities have 8 hours per day, and St. Louis has the fewest with 6.4 hours.

Table 2.2
Comparison of Phoenix to Peer and Larger Urban Areas – 2000 Urbanized Area
Population Density and Growth

| Sorted by Pop Density | Pop Density per Square Mile | Sorted by Pop Density | Central City Pop Density | Sorted by Rank | % Pop Change 1982 to 2000 | Rank | Sorted by Rank | % Pop Change 1994 to 2000 | Rank |
|--------------------------|-----------------------------------|--------------------------|-----------------------------|-------------------|---------------------------------|----------|-------------------|---------------------------------|----------|
| Los Angeles | 5,600 | San Francisco | 23,609 | Atlanta | 85 | 1 | Atlanta | 24 | 1 |
| Miami-Hialeah | 4,055 | Chicago-NE IL | 11,979 | Phoenix | 82 | 2 | Phoenix | 22 | 2 |
| San Diego | 3,590 | Boston | 11,537 | Dallas-Fort Worth | 55 | 3 | Dallas-Fort Worth | 18 | 3 |
| Washington, DC | 3,455 | Minn/St. Paul | 11,264 | San Diego | 52 | 4 | Miami-Hialeah | 17 | 4 |
| Philadelphia | 3,315 | Philadelphia | 10,940 | Minn/St. Paul | 41 | 5 | Houston | 15 | 5 |
| San Francisco | 3,210 | Washington DC | 8,847 | Houston | 41 | 6 | Minn/St. Paul | 14 | 6 |
| Detroit | 3,060 | Los Angeles | 7,572 | Seattle | 39 | 7 | Los Angeles | 6 | 7 |
| Chicago-NE IL | 2,910 | Detroit | 7,212 | Washington DC | 32 | 8 | San Diego | 6 | 8 |
| Baltimore | 2,895 | Seattle | 6,254 | Miami-Hialeah | 31 | 9 | Chicago-NE IL | 5 | 9 |
| Boston | 2,610 | St. Louis | 5,680 | Baltimore | 28 | 10 | Seattle | 5 | 10 |
| Phoenix | 2,320 | San Diego | 3,615 | Los Angeles | 28 | 11 | San Francisco | 4 | 11 |
| Seattle | 2,285 | Baltimore | 3,247 | San Francisco | 22 | 12 | Washington DC | 3 | 12 |
| Minn/St. Paul | 2,005 | Houston | 3,230 | Chicago-NE IL | 14 | 13 | St. Louis | 3 | 13 |
| Dallas-Ft Worth | 1,980 | Dallas-Fort Worth | 3,076 | Philadelphia | 12 | 14 | Baltimore | 2 | 14 |
| Houston | 1,940 | Atlanta | 3,049 | St. Louis | 9 | 15 | Philadelphia | 1 | 15 |
| St. Louis | 1,805 | Phoenix | 2,760 | Boston | 6 | 16 | Boston | 1 | 16 |
| Atlanta | 1,640 | Miami-Hialeah | NA | Detroit | 6 | 17 | Detroit | 0 | 17 |

Exhibit A-1^a

TCRP Table 3.1A^c

Exhibit A-1^a

Exhibit A-1^a

^a2002 Urban Mobility Report; Schrank and Lomax, TTI, June 2002.
^bTexas Transportation Institute website <http://mobility.tama.edu>.
^cTCRP Report 73 by TRB, 2002, and data generally based on 1996.

Table 2.3
Comparison of Phoenix to Peer and Larger Urban Areas – 2000 Urbanized Area
System Size

| Sorted by Miles/Sq Mi | Freeway Lane Miles per Square Mile | Sorted by Miles/Capita | Freeway Lane Miles per 1,000 Capita | Sorted by Miles/Sq Mi | Principal Arterial Lane Miles per Square Mile | Sorted by Miles/Capita | Principal Arterial Lane Miles per 1,000 Capita |
|---------------------------|--|---------------------------|---|--------------------------|---|---------------------------|--|
| Los Angeles | 2.384 | Dallas-Fort Worth | 0.829 | Los Angeles | 4.83 | Miami-Hialeah | 1.19 |
| San Diego | 2.377 | Atlanta | 0.778 | Miami-Hialeah | 4.82 | Phoenix | 1.18 |
| Baltimore | 1.967 | Houston | 0.733 | Detroit | 3.32 | Detroit | 1.09 |
| San Francisco | 1.861 | Baltimore | 0.680 | Phoenix | 2.74 | Dallas-Fort Worth | 1.08 |
| Washington DC | 1.830 | San Diego | 0.662 | San Diego | 2.42 | St. Louis | 0.95 |
| Dallas-Fort Worth | 1.641 | Seattle | 0.643 | Washington DC | 2.34 | Los Angeles | 0.86 |
| Seattle | 1.469 | Minn/St. Paul | 0.638 | Philadelphia | 2.19 | Houston | 0.83 |
| Houston | 1.422 | San Francisco | 0.579 | Dallas-Fort Worth | 2.15 | Seattle | 0.76 |
| Detroit | 1.380 | St. Louis | 0.554 | Baltimore | 1.91 | Atlanta | 0.75 |
| Miami-Hialeah | 1.339 | Washington DC | 0.529 | Boston | 1.78 | Boston | 0.68 |
| Minn/St. Paul | 1.279 | Detroit | 0.451 | Seattle | 1.74 | Washington DC | 0.68 |
| Atlanta | 1.275 | Boston | 0.431 | St. Louis | 1.72 | San Diego | 0.68 |
| Philadelphia | 1.256 | Los Angeles | 0.426 | San Francisco | 1.71 | Baltimore | 0.66 |
| Boston | 1.125 | Phoenix | 0.396 | Chicago-NE IL | 1.62 | Philadelphia | 0.66 |
| St. Louis | 1.000 | Philadelphia | 0.379 | Houston | 1.61 | Chicago-NE IL | 0.56 |
| Chicago-NE IL | 0.960 | Miami-Hialeah | 0.330 | Atlanta | 1.24 | San Francisco | 0.53 |
| Phoenix | 0.920 | Chicago-NE IL | 0.329 | Minn/St. Paul | 1.05 | Minn/St. Paul | 0.52 |
| Calculated from Table 2.1 | | | Calculated from Table 2.1 | | Calculated from Table 2.1 | | |

^a2002 Urban Mobility Report; Schrank and Lomax, TTI, June 2002.

^bTexas Transportation Institute website <http://mobility.tama.edu>.

Table 2.4
Comparison of Phoenix to Peer and Larger Urban Areas – 2000 Urbanized Area
System Utilization

| Sorted by VMT/Mile | Freeway VMT per Lane Mile | Sorted by VMT/Mile | Principal Arterial VMT per Lane Mile | Sorted by % Lane Miles | % Congested Freeway Lane Miles in Peak Period | Sorted by % Lane Miles | % Congested Principal Arterial Lane Miles in Peak Period | Sorted by Hours of Congestion | Daily Hours of Congestion |
|-----------------------|---------------------------------|-----------------------|--|---------------------------|--|---------------------------|---|-------------------------------------|------------------------------|
| Los Angeles | 23,425 | Washington DC | 8,325 | Los Angeles | 85 | Chicago-NE IL | 75 | Los Angeles | 8.0 |
| San Francisco | 20,550 | Boston | 8,060 | San Francisco | 75 | Washington DC | 75 | San Francisco | 8.0 |
| Phoenix | 18,860 | Chicago-NE IL | 7,425 | San Diego | 75 | Boston | 75 | Washington DC | 8.0 |
| San Diego | 18,800 | Atlanta | 7,200 | Phoenix | 75 | Los Angeles | 70 | Chicago-NE IL | 7.8 |
| Atlanta | 18,550 | San Francisco | 7,045 | Seattle | 75 | Atlanta | 70 | Boston | 7.8 |
| Washington DC | 18,320 | Philadelphia | 7,025 | Washington DC | 70 | Philadelphia | 65 | Atlanta | 7.8 |
| Chicago-NE IL | 18,160 | Miami-Hialeah | 6,890 | Atlanta | 70 | Detroit | 65 | San Diego | 7.8 |
| Miami-Hialeah | 18,115 | Detroit | 6,730 | Chicago-NE IL | 65 | Minn/St. Paul | 65 | Miami-Hialeah | 7.8 |
| Boston | 17,610 | Los Angeles | 6,620 | Miami-Hialeah | 65 | Miami-Hialeah | 65 | Detroit | 7.6 |
| Seattle | 17,475 | Baltimore | 6,270 | Detroit | 60 | St. Louis | 65 | Phoenix | 7.6 |
| Detroit | 17,150 | Minn/St. Paul | 6,235 | Houston | 60 | Seattle | 65 | Minn/St. Paul | 7.6 |
| Minn/St. Paul | 17,150 | San Diego | 6,060 | Boston | 60 | San Francisco | 60 | Seattle | 7.6 |
| Dallas-Fort Worth | 15,460 | Seattle | 5,965 | Minn/St. Paul | 60 | San Diego | 60 | Philadelphia | 7.0 |
| Baltimore | 15,365 | Phoenix | 5,880 | St. Louis | 55 | Baltimore | 60 | Dallas-Fort Worth | 7.0 |
| Houston | 15,315 | Dallas-Fort Worth | 5,875 | Dallas-Fort Worth | 50 | Dallas-Fort Worth | 50 | Houston | 7.0 |
| Philadelphia | 14,625 | Houston | 5,860 | Baltimore | 50 | Houston | 50 | Baltimore | 7.0 |
| St. Louis | 14,460 | St. Louis | 5,675 | Philadelphia | 40 | Phoenix | 50 | St. Louis | 6.4 |
| Exhibit A-17a | | | Exhibit A-17a | Exhibit A-13a | | | Exhibit A-13a | Mobility Datab | |

^a2002 Urban Mobility Report; Schrank and Lomax, TTI, June 2002.

^bTexas Transportation Institute website <http://mobility.tamu.edu>.

Table 2.5 provides a continuation of statistics regarding congestion. Phoenix ranks in the middle in average peak-hour speeds on freeways and principal arterials. It is also in the middle in the TTI Roadway Congestion Index (RCI) which is a measure of the intensity and duration of congestion. Phoenix also ranks in the middle for percentage of congested VMT in the peak hours, but in the lower portion of the percentage of congested lane miles in the peak hours. This suggests that the congested VMT is focused on relatively fewer lane miles compared with other cities.

Table 2.6 provides comparative data on the change in congestion over two time periods: 1982 to 2000 and 1994 to 2000. Over the 18-year period, Phoenix was the second fastest growing urban area, but was in the lower group for increase in the RCI with an increase of 32. This may reflect large-scale road building in greater Phoenix during this period. Minneapolis, Atlanta, and San Diego all had RCI increases of over 50, while St. Louis, Seattle, and Houston had the smallest increases in RCI.

The 1994 to 2000 change shows a different picture. Phoenix was the second fastest growing urban area and had the largest increase in the RCI with 23. Atlanta, the fastest growing urban area, had the second largest increase in RCI with 19. Miami and Houston, both rapidly growing urban areas, had very low increases in RCI.

The other two tables in Table 2.6 provide the percentage change in daily congested travel for the two time periods. The results are somewhat similar to the change in RCI.

2.5 Transit

Displayed in Table 2.7 are various statistics on transit system usage and size for the 17 large urbanized areas. In the year 2000, Phoenix had the fewest boardings per mile of service and the second fewest boardings per capita. Detroit, Dallas-Fort Worth, St. Louis, and Houston also had low rates of boardings per capita. Boston, San Francisco, and Washington, D.C. had the highest rates as a result of their extensive subway or light rail systems. These high rates are not too surprising in these older, dense urban areas. Perhaps somewhat surprising is Los Angeles with the third highest rate of boardings per mile, higher than Washington, D.C., San Francisco, and Chicago.

As a measure of system size and coverage, Table 2.7 also provides the miles of service per capita and per square mile. The Phoenix urban area ranks third from last in both categories. Seattle, San Francisco, and Washington, D.C., are the top three in both categories. Dallas-Fort Worth, Detroit, Houston, and St. Louis join Phoenix in the lower group.

2.6 Summary of Comparisons

Table 2.8 presents a summary of how the Phoenix urban area ranking compares with the 16 other largest urban areas in the nation (excluding New York).

Phoenix is the 12th largest urban area and the 11th densest, but Phoenix lacks the dense central city urban core that most older cities have. Phoenix was second in rate of growth from 1982 to 2000 and 1994 to 2000. Phoenix ranks near the bottom in the size of its freeway system and near the top in the amount of travel and congestion on the freeways. On the other hand, Phoenix has one of the most extensive principal arterial systems, and that system is among the least congested.

Using the TTI RCI as an overall measure of road congestion, Phoenix ranks 9th in 2000, but that index increased faster between 1994 and 2000 than in any other urban area. Phoenix ranks at or near the bottom in transit system usage and system size.

Table 2.5
Comparison of Phoenix to Peer and Larger Urban Areas – 2000 Urbanized Area
Level of Congestion

| Sorted by Speed | 1996 Average Peak Period Freeway Speed* | Sorted by Speed | 1996 Average Peak Period Arterial Speed* | Sorted by Index | 2000 TTI Roadway Congestion Index | Sorted by % Congested | % Congested VMT in Peak Hours | Sorted by % Congested | % Congested Lane Miles in Peak Hours |
|--------------------|---|--------------------|--|--------------------|--|--------------------------|-------------------------------------|--------------------------|--|
| St. Louis | 55 | Minn/St. Paul | 30 | Los Angeles | 1.59 | Los Angeles | 90 | Los Angeles | 75 |
| Minn/St. Paul | 54 | San Diego | 30 | San Francisco | 1.45 | San Francisco | 83 | Washington DC | 73 |
| Philadelphia | 53 | Houston | 30 | Washington DC | 1.35 | Washington DC | 81 | Chicago-NE IL | 72 |
| Dallas-Fort Worth | 50 | Dallas-Fort Worth | 30 | San Diego | 1.32 | Chicago-NE IL | 80 | Atlanta | 70 |
| Baltimore | 49 | Baltimore | 29 | Atlanta | 1.32 | Atlanta | 79 | Seattle | 70 |
| Boston | 48 | Phoenix | 29 | Chicago-NE IL | 1.31 | San Diego | 79 | Boston | 69 |
| Houston | 47 | Philadelphia | 29 | Boston | 1.30 | Seattle | 79 | San Francisco | 68 |
| Detroit | 47 | Seattle | 28 | Miami-Hialeah | 1.28 | Miami-Hialeah | 77 | San Diego | 67 |
| Phoenix | 46 | Detroit | 28 | Phoenix | 1.27 | Boston | 76 | Miami-Hialeah | 65 |
| San Diego | 44 | San Francisco | 28 | Seattle | 1.23 | Phoenix | 72 | Detroit | 64 |
| Washington DC | 44 | Chicago-NE IL | 28 | Minn/St. Paul | 1.22 | Detroit | 71 | Minn/St. Paul | 62 |
| Chicago-NE IL | 44 | Los Angeles | 28 | Detroit | 1.22 | Minn/St. Paul | 71 | St. Louis | 60 |
| Seattle | 42 | St. Louis | 27 | Dallas-Fort Worth | 1.10 | Houston | 65 | Philadelphia | 56 |
| San Francisco | 40 | Boston | 27 | Philadelphia | 1.10 | Baltimore | 61 | Phoenix | 56 |
| Los Angeles | 35 | Washington DC | 26 | Baltimore | 1.10 | Philadelphia | 60 | Houston | 55 |
| | | | | Houston | 1.09 | Dallas-Fort Worth | 59 | Baltimore | 55 |
| | | | | St. Louis | 1.03 | St. Louis | 59 | Dallas-Fort Worth | 50 |
| TCRP Table 9.1c | | | TCRP Table 9.1c | Exhibit A-16a | | Mobility Datab | | Mobility Datab | |

*No data for Atlanta and Miami.

^a2002 Urban Mobility Report; Schrank and Lomax, TTI, June 2002.

^bTexas Transportation Institute website <http://mobility.tama.edu>.

^cTCRP Report 73 by TRB, 2002, and data generally based on 1996.

Table 2.6
Comparison of Phoenix to Peer and Larger Urban Areas – 2000 Urbanized Area
Change in Level of Congestion

| Sorted by Change in Index | Change in Roadway Congestion Index 1982 to 2000 | Rank of Pop Change | Sorted by Change in Index | Change in Roadway Congestion Index 1994 to 2000 | Rank of Pop Change | Sorted by % Point Change | % Point Change in Daily Congested Travel 1982 to 2000 | Sorted by % Point Change | % Point Change in Daily Congested Travel 1994 to 2000 |
|------------------------------|--|-----------------------|------------------------------|--|-----------------------|-----------------------------|---|-----------------------------|---|
| Minn/St. Paul | 56 | 5 | Phoenix | 23 | 2 | Atlanta | 28 | Atlanta | 11 |
| Atlanta | 55 | 1 | Atlanta | 19 | 1 | Minn/St. Paul | 28 | Minn/St. Paul | 11 |
| San Diego | 53 | 4 | Minn/St. Paul | 18 | 6 | San Diego | 26 | Dallas-Fort Worth | 9 |
| Boston | 42 | 16 | San Diego | 16 | 8 | Boston | 22 | Houston | 7 |
| San Francisco | 39 | 12 | Chicago-NE IL | 14 | 9 | Dallas-Fort Worth | 20 | Phoenix | 6 |
| Dallas-Fort Worth | 37 | 3 | San Francisco | 14 | 11 | Baltimore | 19 | Baltimore | 6 |
| Chicago-NE IL | 36 | 13 | Dallas-Fort Worth | 14 | 3 | Seattle | 19 | St. Louis | 6 |
| Washington DC | 36 | 8 | Seattle | 14 | 10 | Detroit | 18 | Chicago-NE IL | 5 |
| Baltimore | 35 | 10 | Boston | 11 | 16 | Chicago-NE IL | 17 | Los Angeles | 4 |
| Detroit | 33 | 17 | Philadelphia | 10 | 15 | Miami-Hialeah | 16 | Philadelphia | 4 |
| Miami-Hialeah | 33 | 9 | Baltimore | 10 | 14 | St. Louis | 16 | Boston | 4 |
| Phoenix | 32 | 2 | Los Angeles | 9 | 7 | Washington DC | 15 | San Diego | 4 |
| Los Angeles | 30 | 11 | Houston | 9 | 5 | Phoenix | 15 | Detroit | 3 |
| Philadelphia | 28 | 14 | Detroit | 7 | 17 | Los Angeles | 14 | Miami-Hialeah | 3 |
| St. Louis | 16 | 15 | Miami-Hialeah | 6 | 4 | Philadelphia | 14 | Seattle | 3 |
| Seattle | 16 | 7 | St. Louis | 4 | 13 | San Francisco | 14 | San Francisco | 2 |
| Houston | 6 | 6 | Washington DC | 1 | 12 | Houston | 7 | Washington DC | 1 |
| Exhibit A-18a | | | Exhibit A-18a | | | Exhibit A-10a | | Exhibit A-10a | |

^a2002 Urban Mobility Report; Schrank and Lomax, TTI, June 2002.

Table 2.7
Comparison of Phoenix to Peer and Larger Urban Areas – 2000 Urbanized Area
Transit Data

| Sorted by Boardings/Mile | Annual Boardings/ Revenue Mile | Sorted by Miles/Capita | Annual Revenue Miles/Capita | Sorted by Miles/Square Mile | Revenue Miles (000)/ Square Mile |
|--------------------------|-----------------------------------|---------------------------|--------------------------------|-----------------------------------|-------------------------------------|
| Philadelphia | 4.20 | Seattle | 41.1 | San Francisco | 112.4 |
| Boston | 4.19 | San Francisco | 35.0 | Washington DC | 99.0 |
| Los Angeles | 4.09 | Washington DC | 28.6 | Seattle | 93.9 |
| Washington DC | 3.74 | Boston | 28.0 | Boston | 73.0 |
| Atlanta | 3.34 | Chicago-NE IL | 23.6 | Chicago-NE IL | 68.8 |
| Chicago-NE IL | 3.13 | Philadelphia | 17.1 | Los Angeles | 63.6 |
| Baltimore | 3.11 | Atlanta | 17.1 | San Diego | 59.5 |
| San Francisco | 3.09 | Baltimore | 17.1 | Philadelphia | 56.6 |
| Miami-Hialeah | 2.79 | San Diego | 16.6 | Miami-Hialeah | 55.7 |
| San Diego | 2.29 | Minn/St. Paul | 16.3 | Baltimore | 49.5 |
| Houston | 2.27 | Miami-Hialeah | 13.7 | Minn/St. Paul | 32.6 |
| St. Louis | 2.18 | Houston | 13.1 | Atlanta | 28.1 |
| Dallas-Fort Worth | 2.13 | St. Louis | 12.2 | Detroit | 25.7 |
| Minn/St. Paul | 1.97 | Los Angeles | 11.4 | Houston | 25.4 |
| Detroit | 1.69 | Phoenix | 10.0 | Phoenix | 23.2 |
| Seattle | 1.59 | Dallas-Fort Worth | 9.2 | St. Louis | 22.0 |
| Phoenix | 1.53 | Detroit | 8.4 | Dallas-Fort Worth | 18.2 |

Federal Transit Administration National Transit Database for 2000.

Table 2.8
Ranking of Phoenix Urban Area in 2000
Out of 17 Largest Urban Areas

| Population | Phoenix Ranking |
|--|------------------------|
| Population | 12 |
| Square Miles of Urban Area | 12 |
| Urban Area Population Density | 11 |
| Central City Population Density (1996) | 16 |
| Population Increase | 2 |
| | |

| Freeways | Phoenix Ranking |
|--------------------------------|------------------------|
| Freeway Lane Miles | 16 |
| Freeway VMT | 16 |
| Freeway Lane Miles/Sq Mi | 17 |
| Freeway Lane Miles/Capita | 14 |
| Freeway VMT/Lane Miles | 3 |
| % Congested Freeway Lane Miles | 4 |

| Arterials | Phoenix Ranking |
|---|------------------------|
| Principal Arterial Lane Miles | 5 |
| Principal Arterial VMT | 8 |
| Principal Arterial Lane Miles/Sq Mi | 4 |
| Principal Arterial Lane Miles/Capita | 2 |
| Principal Arterial VMT/Lane Miles | 14 |
| % Congested Principal Arterial Lane Miles | Tie 15-17 |

| Vehicle Miles | Phoenix Ranking |
|------------------------|------------------------|
| Roadway System Miles | 10 |
| Roadway System VMT | 14 |
| % Congested VMT | 10 |
| % Congested Lane Miles | 14 |
| | |
| | |

| Congestion | Phoenix Ranking |
|--|------------------------|
| Roadway Congestion Index (RCI) | 9 |
| 1982-2000 Change in RCI | 12 |
| 1994-2000 Change in RCI | 1 |
| % Point Change in Congestion 1982-2000 | 12 |
| % Point Change in Congestion 1994-2000 | 5 |
| Daily Hours of Congestion | Tie 9-12 |

| Transit | Phoenix Ranking |
|--------------------------|------------------------|
| Transit Boardings/Capita | 16 |
| Transit Boardings/Mile | 17 |
| Transit Miles/Capita | 15 |
| Transit Miles/Sq Mi | 15 |
| | |
| | |

2.7 Correlation of Urban Characteristics to Congestion

In an effort to identify those characteristics of urban areas that relate to levels of congestion, certain characteristics from the foregoing data were selected and compared to the RCI. This index is a measure of the intensity and duration of congestion. All data represent 2000 urban areas and were taken from Tables 2.1 through 2.7.

The six characteristics that were selected for comparison are population, density, growth rate, transit usage, freeway lane miles per capita, and freeway lane miles per square mile. Population was taken from Table 2.1, population density from Table 2.2, growth rate between 1994 and 2000 from Table 2.2, transit boardings per capita from Table 2.7, and freeway lane miles from Table 2.3. The RCI was taken from Table 2.5. This evaluation was prepared to provide insight into the following questions:

- Are larger cities more congested than smaller cities?
- Are more dense cities more congested than less dense cities?
- Are faster growing cities more congested than slower growing cities?
- Are cities with high transit usage less congested than cities with low transit usage?
- Do cities with fewer lane miles per capita or per square mile have more congestion?
- Which of the above urban characteristics are better correlated to congestion?

Table 2.9 displays the comparison of population and density to the RCI. The 2000 urban area population for each of the 17 urban areas is shown and ranked from 1 to 17. The RCI rank for each city is also displayed. The rank for the RCI was subtracted from the population rank and the result sorted from low to high. The results are shown in the right two columns of each table in the table.

For the comparison with population, a negative number indicates that a city has a large population (low rank) and relatively less congestion (high rank). For example, Philadelphia is the third most populated urban area, but its congestion index ranking is 14, the result is $3 - 14 = -11$. Seattle, on the other hand, is ranked 17 in population and 10 in RCI with a net result of $+7$. If there were a perfect correlation between population size and RCI, then each result would equal zero.

By adding the absolute numbers, a relative correlation value was determined. A lower correlation number indicates a better correlation. Zero is the lowest possible number and 136 is the largest possible number (17 cities times an average difference of 8). For population, that relative correlation number is 76.

A similar process was used for density. Negative numbers indicate cities with relatively high densities (low rankings) and lower relative congestion indices (high rankings). The sum of the absolute numbers provides a relative correlation number of 58. This number indicates that density is better correlated to congestion than is population.

Table 2.10 displays similar correlation calculations for growth rate and transit usage. The RCI index ranking was subtracted from the growth rate ranking (1994 to 2000). A negative result indicates an urban area with a high growth rate and a low congestion index. This evaluation indicates that fast-growing Houston, Dallas-Fort Worth, and Phoenix have been better able to meet their growing transportation needs than cities such as San Francisco, Washington, D.C., and Boston. The relative correlation is 92, which indicates that congestion is less correlated with growth rate than with either density or population.

Table 2.9
Urban Area Data Correlation with Roadway Congestion Index (RCI)
Population and Density

| Population vs. RCI | | | | | Density vs. RCI | | | |
|----------------------|-------------------------|----------|----------|----------------------|-------------------|--------------|----------|-----------------------|
| Sorted by Population | 2000 Population (1000s) | Pop Rank | RCI Rank | Sorted by Pop-RCI | Sorted by Density | Density Rank | RCI Rank | Sorted by Density-RCI |
| Los Angeles | 12,680 | 1 | 1 | -11 Philadelphia | Los Angeles | 1 | 1 | -9 Philadelphia |
| Chicago-NE IL | 8,090 | 2 | 6 | -8 Houston | Miami-Hialeah | 2 | 8 | -6 Miami-Hialeah |
| Philadelphia | 4,590 | 3 | 14 | -7 Detroit | San Diego | 3 | 4 | -6 Baltimore |
| San Francisco | 4,030 | 4 | 2 | -7 Dallas-Fort Worth | Washington DC | 4 | 3 | -5 Detroit |
| Detroit | 4,025 | 5 | 12 | -4 Chicago-NE IL | Philadelphia | 5 | 14 | -1 San Diego |
| Dallas-Fort Worth | 3,800 | 6 | 13 | -1 St. Louis | San Francisco | 6 | 2 | -1 Houston |
| Washington DC | 3,560 | 7 | 3 | 0 Los Angeles | Detroit | 7 | 12 | -1 St. Louis |
| Houston | 3,375 | 8 | 16 | 0 Baltimore | Chicago-NE IL | 8 | 6 | 0 Los Angeles |
| Boston | 3,025 | 9 | 7 | 2 San Francisco | Baltimore | 9 | 15 | 1 Washington DC |
| Atlanta | 2,975 | 10 | 5 | 2 Boston | Boston | 10 | 7 | 1 Dallas-Fort Worth |
| San Diego | 2,710 | 11 | 4 | 2 Minn/St. Paul | Phoenix | 11 | 9 | 2 Chicago-NE IL |
| Phoenix | 2,600 | 12 | 9 | 3 Phoenix | Seattle | 12 | 10 | 2 Phoenix |
| Minn/St. Paul | 2,475 | 13 | 11 | 4 Washington DC | Minn/St. Paul | 13 | 11 | 2 Seattle |
| Miami-Hialeah | 2,270 | 14 | 8 | 5 Atlanta | Dallas-Fort Worth | 14 | 13 | 2 Minn/St. Paul |
| Baltimore | 2,170 | 15 | 15 | 6 Miami-Hialeah | Houston | 15 | 16 | 3 Boston |
| St. Louis | 2,040 | 16 | 17 | 7 San Diego | St. Louis | 16 | 17 | 4 San Francisco |
| Seattle | 2,000 | 17 | 10 | 7 Seattle | Atlanta | 17 | 5 | 12 Atlanta |

Relative Correlation = 76

Relative Correlation = 58

Table 2.10
Urban Area Data Correlation with Roadway Congestion Index (RCI)
Growth Rates and Transit Usage

| Growth Rate vs. RCI | | | | Transit Usage vs. RCI | | | |
|-------------------------------------|--------------------|----------|-----------------------------|--------------------------------------|---------------------------------|----------|--------------------------|
| Sorted by Change in Pop 94-00 | Pop Change Rank | RCI Rank | Sorted by Pop Change-RCI | Sorted by Boardings per Capita | Boardings per Capita Rank | RCI Rank | Sorted by Transit-RCI |
| Atlanta | 1 | 5 | Houston | Boston | 17 | 7 | St. Louis |
| Phoenix | 2 | 9 | Dallas-Fort Worth | San Francisco | 16 | 2 | Houston |
| Dallas-Fort Worth | 3 | 13 | Phoenix | Washington DC | 15 | 3 | Detroit |
| Miami-Hialeah | 4 | 8 | Minn/St. Paul | Chicago-NE IL | 14 | 6 | Dallas-Fort Worth |
| Houston | 5 | 16 | Atlanta | Philadelphia | 13 | 14 | Phoenix |
| Minn/St. Paul | 6 | 11 | Miami-Hialeah | Seattle | 12 | 10 | Baltimore |
| Los Angeles | 7 | 1 | St. Louis | Atlanta | 11 | 5 | Minn/St. Paul |
| San Diego | 8 | 4 | Baltimore | Baltimore | 10 | 15 | Philadelphia |
| Chicago-NE IL | 9 | 6 | Seattle | Los Angeles | 9 | 1 | Miami-Hialeah |
| Seattle | 10 | 10 | Philadelphia | Miami-Hialeah | 8 | 8 | Seattle |
| San Francisco | 11 | 2 | Chicago-NE IL | San Diego | 7 | 4 | San Diego |
| Washington DC | 12 | 3 | San Diego | Minn/St. Paul | 6 | 11 | Atlanta |
| St. Louis | 13 | 17 | Detroit | Houston | 5 | 16 | Chicago-NE IL |
| Baltimore | 14 | 15 | Los Angeles | St. Louis | 4 | 17 | Los Angeles |
| Philadelphia | 15 | 14 | San Francisco | Dallas-Fort Worth | 3 | 13 | Boston |
| Boston | 16 | 7 | Washington DC | Phoenix | 2 | 9 | Washington DC |
| Detroit | 17 | 12 | Boston | Detroit | 1 | 12 | San Francisco |

Relative Correlation = 92

Relative Correlation = 126

Table 2.10 also displays the comparison of transit boardings per capita to the RCI. Since the hypothesis was that more transit usage leads to less congestion (high ranking), the ranks for transit usage were reversed so that the urban area with the highest boardings per capita was ranked 17 while the fewest boardings per capita was ranked 1. After subtracting the RCI rank from the reversed rank of boardings per capita, a negative number indicates an urban area with low relative transit usage (low rank) and low relative congestion (high rank). St. Louis, Houston, and Detroit each have lower transit usage and still have a relative low congestion index. On the other hand, Boston, Washington, D.C., and San Francisco have high transit usage and still have relative high congestion indices. The relative correlation is 126, which indicates that transit usage is less correlated to congestion than the other three parameters discussed previously.

Table 2.11 displays the comparison of freeway lane miles per capita and per square mile to the RCI. The lane mile rankings were ranked in reverse order, i.e., the lowest lane miles received a ranking of 1 and the highest lane miles received a ranking of 17. The lane miles per capita has the second best relative correlation (86) of all the factors considered.

An additional analysis was conducted to determine if those factors that have a high relative correlation shown in Tables 2.9 through 2.11 also have a statistical correlation. The two factors with the highest relative correlation are population density and freeway lane miles per capita. A linear regression analysis was conducted with each factor versus the RCI and then for the combination of the two factors. The R^2 value from the regression analyses indicates the degree of correlation. An R^2 value approaching 1.0 indicates strong correlation while a value approaching 0.0 indicates a weak correlation. The R^2 for the population density was 0.442 which indicates a very modest statistical correlation. The R^2 for freeway lane miles per capita to RCI was 0.094 which indicates little correlation. The combined factors had an R^2 of 0.445, only slightly better than population density by itself. This analysis raises questions regarding the statistical correlation of urban factors and the RCI. There appears to be too many variables to conclude that any one or two urban factors correlates with more or less congestion as measured by the RCI.

Table 2.11
Comparison of Freeway Lane Miles per Capita
and Per Square Mile to RCI

| Lane Miles per Capita vs. RCI | | | | | Lane Miles per Square Mile vs. RCI | | | | |
|--------------------------------|----------------------|------|----------|---------------------------|-------------------------------------|---------------------------|------|----------|---------------------------|
| Sorted by Lane Mile per Capita | Lane Mile per Capita | Rank | RCI Rank | Sorted by Lane Mile - RCI | Sorted by Lane Mile per Square Mile | Lane Mile per Square Mile | Rank | RCI Rank | Sorted by Lane Mile - RCI |
| Chicago-NE IL | 0.329 | 1 | 6 | -11 Philadelphia | Phoenix | 0.920 | 1 | 9 | -14 St. Louis |
| Miami-Hialeah | 0.330 | 2 | 8 | -8 St. Louis | Chicago-NE IL | 0.960 | 2 | 6 | -9 Philadelphia |
| Philadelphia | 0.379 | 3 | 14 | -6 Miami-Hialeah | St. Louis | 1.000 | 3 | 17 | Phoenix |
| Phoenix | 0.396 | 4 | 9 | -5 Chicago-NE IL | Boston | 1.125 | 4 | 7 | Houston |
| Los Angeles | 0.426 | 5 | 1 | -5 Phoenix | Philadelphia | 1.256 | 5 | 14 | -4 Chicago-NE IL |
| Boston | 0.431 | 6 | 7 | -5 Detroit | Atlanta | 1.275 | 6 | 5 | -4 Minn/St. Paul |
| Detroit | 0.451 | 7 | 12 | -1 Boston | Minn/St. Paul | 1.279 | 7 | 11 | -3 Boston |
| Washington DC | 0.529 | 8 | 3 | -1 Baltimore | Miami-Hialeah | 1.339 | 8 | 8 | -3 Detroit |
| St. Louis | 0.554 | 9 | 17 | -1 Houston | Detroit | 1.380 | 9 | 12 | -1 Dallas-Fort Worth |
| San Francisco | 0.579 | 10 | 2 | 0 Minn/St. Paul | Houston | 1.422 | 10 | 16 | 0 Miami-Hialeah |
| Minn/St. Paul | 0.638 | 11 | 11 | 2 Seattle | Seattle | 1.469 | 11 | 10 | 0 Baltimore |
| Seattle | 0.643 | 12 | 10 | 4 Los Angeles | Dallas-Fort Worth | 1.641 | 12 | 13 | 1 Atlanta |
| San Diego | 0.662 | 13 | 4 | 4 Dallas-Fort Worth | Washington DC | 1.830 | 13 | 3 | 1 Seattle |
| Baltimore | 0.680 | 14 | 15 | 5 Washington DC | San Francisco | 1.861 | 14 | 2 | 10 Washington DC |
| Houston | 0.733 | 15 | 16 | 8 San Francisco | Baltimore | 1.967 | 15 | 15 | 12 San Francisco |
| Atlanta | 0.778 | 16 | 5 | 9 San Diego | San Diego | 2.377 | 16 | 4 | 12 San Diego |
| Dallas-Fort Worth | 0.829 | 17 | 13 | 11 Atlanta | Los Angeles | 2.384 | 17 | 1 | 16 Los Angeles |

Relative Correlation = 86

Relative Correlation = 104

3.0 COMPARISON OF ALTERNATIVE GROWTH CONCEPTS

3.1 Background

This chapter compares the forecast socioeconomic and transportation conditions generated by each of four alternative growth concepts for approximately the year 2050, when the population of the MAG region could reach 9 million. (It should be noted that all statistics in this chapter, such as the 9 million population, refer to Maricopa County and northern Pinal County combined.) The previous task report on Alternative Growth Concepts defined these alternatives as follows:

Scenario 1, Base Case/General Plan: This scenario focuses on continued development and planning consistent with new, or soon to be adopted, general plan updates of local MAG member jurisdictions.

Scenario 2, Infill/Urban Revitalization Emphasis: In this scenario, the general plans and development standards of the MAG members within the 101 and 202 loops would require density enhancements along major transportation corridors, in and around activity centers, and within designated redevelopment or development infill areas. Such revisions would focus on increased densities when redevelopment occurs or along fixed-guideway transit corridors; infill development on vacant or redevelopment lands to maximize use of existing infrastructure; and revitalization of existing neighborhoods and the stimulation of mixed use development in high density areas, as part of any new infill or redevelopment project, or as part of urban activity center development. A more compact urban form would result, with 65% to 75% of future growth over the next 50 years occurring within existing urbanized areas, and the remainder on the urban fringe.

Scenario 3, Activity Center Emphasis: This scenario, like Scenario 2, would require revision of general plans and development standards. Such revisions would be similar to Scenario 2; however, the plans would be revised to concentrate future growth and development not only in existing urbanized areas, but also in regionally identified activity centers and along major transportation corridors throughout the metropolitan area.

Scenario 4, Suburban Fringe Growth Emphasis: This scenario would further extend growth and development patterns in the metropolitan areas outward with no encouragement for either infill development or urban revitalization regardless of available infrastructure, no encouragement for nodal activity center development, and emphasis on attempting to achieve a job/housing balance only on a subregional basis. This scenario requires the least in terms of planning and development standards.

The comparative evaluation in this chapter is also intended to take into account the draft goals and objectives previously established in the task report on Values, Goals and Objectives. The four goals for the MAG regional transportation system are:

1. Maintenance and Safety—Transportation infrastructure that is well maintained and safe.
2. Access and Mobility—Affordable transportation services that provide accessibility and mobility for everyone.
3. Sustain the Environment—Transportation improvements that help sustain our environment and quality of life.
4. Accountability and Planning—Transportation decisions that result in effective and efficient use of public resources and strong public support.

3.2 Transportation System Assumptions

3.2.1 Roadway Network Description

The common regional roadway network used with all four growth scenarios consists of existing freeways and arterials plus three levels of improvement: *programmed improvements*, *planned improvements*, and *further capacity additions for modeling purposes*.

Programmed improvements consist of all projects involving increases in freeway or arterial capacity that are currently funded and included in the MAG Five-Year Transportation Improvement Program. These include:

- Programmed capacity improvements to existing freeways, such as the current widening of US 60 from I-10 to Val Vista Drive.
- Completion of the Red Mountain, Santan and Squaw Peak freeways, and the Sky Harbor Expressway—all scheduled for 2007 or sooner.
- Grade separations to eliminate the existing six-leg intersections on Grand Avenue (US 60) at Thomas Road/27th Avenue, Camelback Road/43rd Avenue, Bethany Home Road/51st Avenue, Maryland Avenue/55th Avenue, Glendale Avenue/59th Avenue, Northern Avenue/67th Avenue, and Olive Avenue/75th Avenue—likewise scheduled for 2007 or sooner.
- Various improvements to the arterial street system, funded primarily by local jurisdictions including cities, towns and Maricopa County.

Planned improvements consist of capacity-increasing projects incorporated in the latest MAG Long Range Transportation Plan (LRTP) Update and the accompanying regional freeway and arterial network for 2025. Major improvements in the LRTP include:

- South Mountain Parkway (southwest portion of Loop 202)
- Loop 303 (Estrella Expressway) from MC 85 to I-17
- Grand Expressway (US 60)
- Extension of the Agua Fria Freeway corridor from I-10 to Buckeye Road
- Additional lanes on I-17 from Thomas to Thunderbird Roads
- A collector/distributor road system along I-10/I-17 from Baseline Road to 16th Street
- HOV lanes on the Squaw Peak Parkway from I-10 to Shea Boulevard
- Upgrade of SR 85 (I-10 to I-8) to a four-lane divided facility with controlled access
- Expansion of the following arterials into multilane divided highways, with substantially greater capacity than standard arterials: SR 74, SR 87, MC 85, SR 347 (Maricopa Road), SR 387, and Northern Avenue from Grand Avenue to Loop 303
- Extension of the existing arterial system to serve newly developing and urbanizing areas on the fringes of the region, including portions of Pinal County

Further capacity additions for modeling purposes represent expansion of the roadway network required to cover a metropolitan region of approximately 9 million people, representing a geographical area much larger than in 2025. Although the details of long-term regional growth patterns differ by scenario, a single freeway and arterial network was tested to facilitate comparative impact analysis of the scenarios. The

facilities coded into the MAG 2050 modeled network include not only large-scale expansion of the roadway system into outlying areas, but also increasing capacities on freeways and other roads to accommodate anticipated travel demand from the population of 9 million. It should be emphasized that these coded improvements do not represent a plan and have been assumed for analytical purposes only, without any attempt to judge the feasibility of any specific element. In addition, transit coverage and service levels were expanded and enhanced throughout the region (see Section 3.2.3).

One reason for inclusion of the capacity and coverage expansions was MAG's previous experience in testing a smaller, 2040 network designed to serve a population of 6.3 million. That network encountered high congestion levels that interfered with the modeling function, so capacity increases were included to avoid modeling breakdown due to a further population increase of nearly 50%.

3.2.2 Roadway Network Statistics

Based on analysis of the future network described in the preceding section, a substantial expansion of the current transportation system will be needed by 2050. Table 3.1 compares the number of lane miles in the existing year 2000 MAG roadway network and the network assumed for the analysis in this chapter. From 2000 to 2050, the assumed growth in roadway system miles is 209% for freeways and 96% for arterials. Overall, this scenario shows lane miles of major roadways increasing by 114% over 50 years. This compares with an assumed population growth of 175% for the same period (see Section 3.3.1).

Table 3.1
Systemwide Freeway and Arterial Lane Miles, 2000-2050

| Facility Type | Lane Miles | | |
|-------------------------------------|---------------|--------------|------------|
| | 2000 Existing | 2050 Assumed | % Increase |
| Freeways | 1,924 | 5,939 | 209% |
| Arterials (including expressways) | 10,517 | 20,636 | 96% |
| Total (freeways and arterials only) | 12,442 | 26,575 | 114% |

Sources: MAG 2000 and 2050 HSTATS.

3.2.3 Transit Network Description

The common 2050 regional transit network used with all four growth scenarios consists of existing fixed route and paratransit services plus three levels of improvement: *programmed (funded) improvements*, *planned improvements*, and *further capacity additions for modeling purpose*.

Programmed improvements consist of all transit capital projects currently funded and included in the MAG Five-Year Transportation Improvement Program as well as operational funding levels predicted in the Valley Metro Annual Short Range Transit Report for Fiscal Year (FY) 2002 through FY 2006. Planned improvements are system expansions in the Valley Metro Long Range Transit Plan and in the latest MAG LRTP Update.

These programmed and planned improvements include:

- A doubling (compared to 1998 levels) of transit operational levels by 2006 is programmed.
- A quadrupling of express bus service and a tripling of trunk line bus service by 2020 is planned.
- A 39-mile light rail transit system serving Phoenix, Glendale, Tempe and Mesa is planned, with over \$1 billion of investment programmed through 2007. This system is illustrated in Figure EX-3 of the

MAG LRTP 2002 Update Executive Summary. The 20.3-mile Minimum Operating Segment from Spectrum Mall in Phoenix to the East Valley Institute of Technology in Mesa is scheduled for construction by 2006.

Standards in the Long Range Transit Plan call for transit service on local trunk route (local fixed route service with frequent stops) corridors from 5 A.M. to midnight, with peak period frequencies of every 15 minutes service and off-peak frequencies of every thirty minutes.

Additional modeling capacity includes an increase in service between 2025 and 2050 similar to the planned increase between 2000 and 2025. While much of the current urban area is expected to have planned levels of transit service, including the light rail corridors, in place prior to 2025, the 2050 modeled improvements assume a significant geographical expansion of the transit service area. Extension of the transit service area during the 2025 to 2050 period will include locations in both newly urbanizing areas of Maricopa County and contiguous areas of Pinal County. Only those areas which are predicted to have population, employment and commercial densities adequate to generate transit patronage comparable to that of existing transit service areas were included in the network.

3.2.4 Transit Network Statistics

Table 3.2 shows the increase in transit revenue miles from the existing service levels to the year 2007 programmed system and the 2050 predicted service levels. The vehicle revenue miles for future years include both bus and rail service.

Table 3.2
Weekday Average Transit Revenue Miles

| Vehicle Revenue Miles | Year | | |
|-----------------------|---------------|-----------------|--------------|
| | 2000 Existing | 2007 Programmed | 2050 Assumed |
| Total | 73,000 | 146,000 | 408,000 |
| % Increase from 2000 | N/A | 100% | 459% |

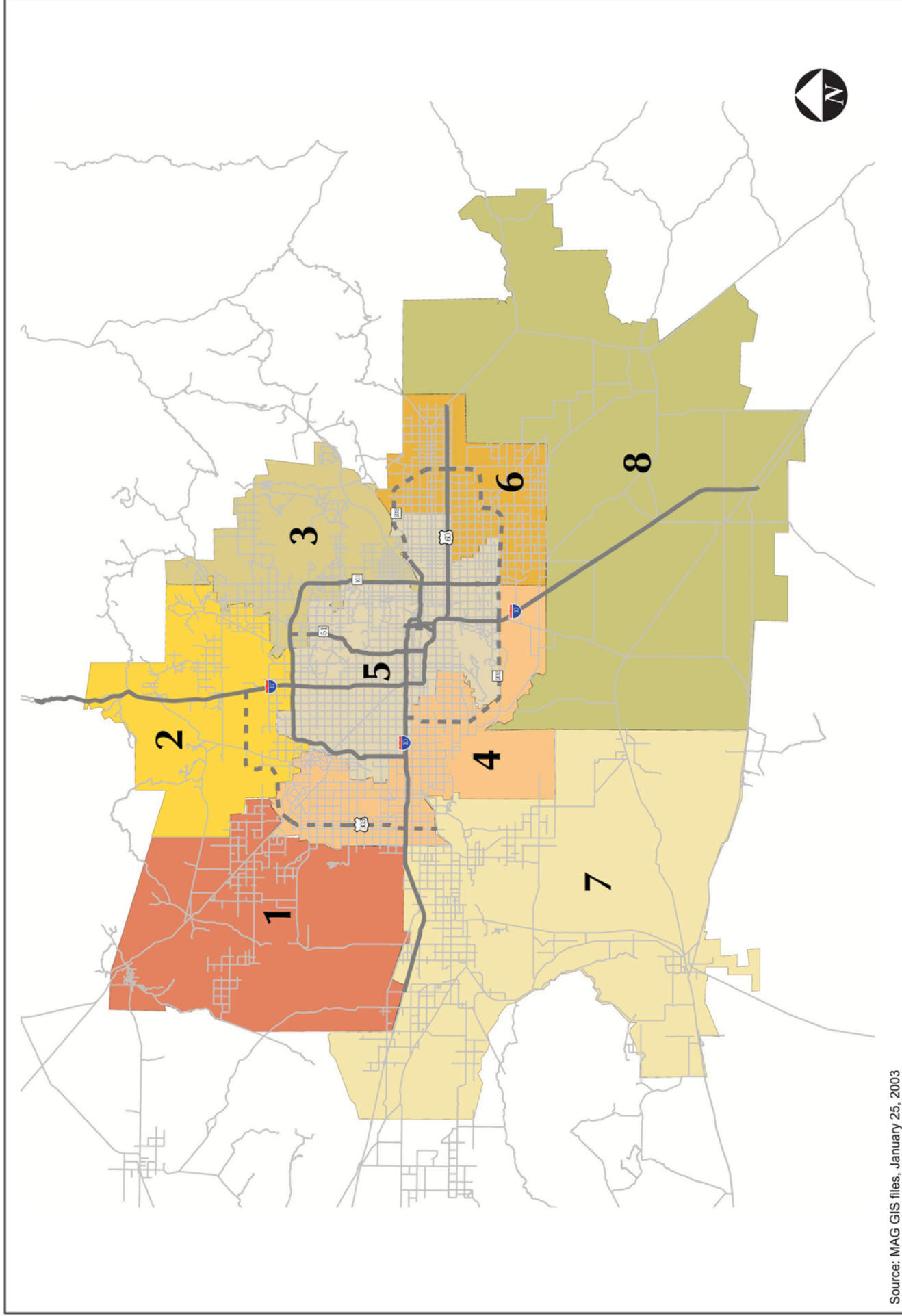
Sources: MAG LRTP, MAG 2050 HSTATS, Valley Metro Long Range Transit Plan, Valley Metro Annual Short Range Transit Report.

3.3 Comparison of Growth Concepts

3.3.1 Population and Employment

Table 3.3 shows existing year 2000 population and employment in the MAG region, as well as projections for the Base Case, Infill, Activity Center and Suburban scenarios. The 2000 regional population of 3.34 million was assumed to increase by 175%, to approximately 9.15 million for each scenario. The Suburban scenario has a slightly higher population than the others. Relative growth in employment is similar—approximately 170%, except under the Suburban scenario, which includes a somewhat higher employment forecast.

Table 3.4 shows the 2000 and assumed distribution of regional population among eight subareas (Geographic Locations) into which the region has been subdivided for this analysis (Figure 3-1). Currently just over two-thirds of the population resides in the Central Area, with another 12% in the Southeast and the remaining 20% scattered throughout the other six subregions. This population



Source: MAG GIS files, January 25, 2003

distribution changes significantly, with a much smaller percentage in the Central Area and substantially higher percentages in the Northwest, North, Northwest/Southwest and Southwest subregions. Even under the Infill scenario, the Central Area's share of the population falls from 68% today to 36%.

Table 3.3
MAG Regional Population and Employment Projections

| Characteristic | Scenario | | | | |
|-------------------|-------------------------|-----------|-----------|-----------------|-----------|
| | Existing (Year 2000) | Base Case | Infill | Activity Center | Suburban |
| Population | 3,334,000 | 9,165,000 | 9,159,000 | 9,165,000 | 9,200,000 |
| Employment | 1,620,000 | 4,368,000 | 4,380,000 | 4,369,000 | 4,691,000 |

Source: U.S. Census 2000 and MAG socioeconomic projections.

Table 3.4
Population Distribution by Geographic Location

| Geographic Location | Population as Percent of Regional Total | | | | |
|---------------------|---|-----------|--------|-----------------|----------|
| | Existing (Year 2000) | Base Case | Infill | Activity Center | Suburban |
| Northwest | 1% | 12% | 5% | 10% | 17% |
| North | 4% | 11% | 11% | 12% | 10% |
| Northeast | 5% | 6% | 6% | 6% | 6% |
| NW/SW | 7% | 12% | 13% | 12% | 9% |
| Central Area | 68% | 31% | 36% | 32% | 29% |
| Southeast | 12% | 11% | 12% | 12% | 11% |
| Southwest | 1% | 13% | 13% | 13% | 14% |
| Pinal County | 3% | 4% | 4% | 4% | 4% |

Source: U.S. Census 2000 and MAG socioeconomic projections.

Certain Geographic Locations (GLs) in Table 3.4 show marked differences between scenarios in relative population, while others do not. The Northwest and Central GLs exhibit the most variation, while the North, Northeast, Southeast, Southwest and Pinal County areas have very little.

Table 3.5 shows similar information on the existing and future distribution of employment across the region. The vast majority of employment (over 70%) is currently concentrated in the Central Area. This proportion drops to 31%-43%, depending on the scenario. Substantial growth in the employment percentage under one or more scenarios is projected for every other GL except the Northeast and Pinal County. As expected, the Central Area retains the highest percentage of regional employment under the Infill scenario, and the lowest with the Suburban growth concept. The Northwest and Southwest GLs attract a far higher proportion of employment with the Suburban growth pattern than with any of the others.

Table 3.5
Employment Distribution by Geographic Location

| Geographic Location | Employment as Percent of Regional Total | | | | |
|----------------------------|--|------------------|---------------|------------------------|-----------------|
| | Existing (Year 2000) | Base Case | Infill | Activity Center | Suburban |
| Northwest | 1% | 5% | 3% | 3% | 9% |
| North | 3% | 8% | 8% | 8% | 7% |
| Northeast | 6% | 7% | 6% | 6% | 7% |
| NW/SW | 7% | 15% | 15% | 15% | 12% |
| Central Area | 71% | 37% | 43% | 40% | 31% |
| Southeast | 8% | 14% | 14% | 15% | 15% |
| Southwest | 1% | 8% | 6% | 8% | 15% |
| Pinal County | 3% | 5% | 5% | 5% | 5% |

Source: U.S. Census 2000 and MAG socioeconomic projections.

Table 3.6 presents existing and assumed population density for the MAG region and by GL. The regional density nearly triples from around 500 persons to 1,400 persons per square mile. Much of this density increase reflects the future development of currently rural areas, rather than densification of the existing urbanized area. For example, the population density of the Northwest area will rise from 19 per square mile today to between 500 and 1,800, depending on the growth scenario. The Central and Southeast areas are the most heavily urbanized and hence show relatively small percentage increases in density. Although Pinal County densities triple, its population density is currently low and remains relatively low. This pattern results in part from the large areas of low density on the Gila River Indian Community. Under any of the growth scenarios, the Central Area will remain the most densely populated and the Southeast GL the second densest.

Table 3.6
Population Density by Geographic Location

| Geographic Location | Population per Square Mile | | | | |
|----------------------------|-----------------------------------|------------------|---------------|------------------------|-----------------|
| | Existing (Year 2000) | Base Case | Infill | Activity Center | Suburban |
| Northwest | 19 | 1,196 | 511 | 1,002 | 1,737 |
| North | 216 | 1,816 | 1,789 | 1,902 | 1,706 |
| Northeast | 406 | 1,131 | 1,186 | 1,186 | 1,132 |
| NW/SW | 344 | 1,664 | 1,872 | 1,710 | 1,334 |
| Central Area | 3,232 | 4,063 | 4,654 | 4,177 | 3,756 |
| Southeast | 731 | 1,985 | 2,095 | 2,063 | 1,948 |
| Southwest | 16 | 764 | 758 | 733 | 803 |
| Pinal County | 44 | 136 | 136 | 136 | 136 |
| MAG Region | 514 | 1,412 | 1,411 | 1,412 | 1,417 |

Source: U.S. Census 2000 and MAG socioeconomic projections.

Similar information on current and future employment density is displayed in Table 3.7. Overall, regional employment density is assumed to increase by 170%-190%, from 249 per square mile today to 723 under the Suburban scenario and about 675 under the other three scenarios. Employment densities increase markedly throughout the region, including the Central Area, which has more than twice the employment density of every other GL except under the Suburban scenario. The Southeast and Northwest/Southwest GLs rank second and third.

Table 3.7
Employment Density by Geographic Location

| Geographic Location | Employment per Square Mile | | | | |
|----------------------------|-----------------------------------|------------------|---------------|------------------------|-----------------|
| | Existing (Year 2000) | Base Case | Infill | Activity Center | Suburban |
| Northwest | 9 | 246 | 148 | 148 | 480 |
| North | 81 | 587 | 612 | 605 | 576 |
| Northeast | 226 | 722 | 547 | 597 | 731 |
| NW/SW | 177 | 1,024 | 1,020 | 1,038 | 859 |
| Central Area | 1,647 | 2,307 | 2,691 | 2,494 | 2,083 |
| Southeast | 244 | 1,176 | 1,196 | 1,223 | 1,288 |
| Southwest | 12 | 223 | 153 | 204 | 422 |
| Pinal County | 18 | 90 | 90 | 90 | 90 |
| MAG Region | 249 | 673 | 675 | 673 | 723 |

Source: U.S. Census 2000 and MAG socioeconomic projections.

3.3.2 Regional Travel Characteristics

Table 3.8 lists the estimated number of daily (weekday) person trips for the year 2050 under each of the four growth scenarios. The Infill scenario has the fewest trips and Activity Center the most, but the variation among alternatives is less than 1%. The average number of trips per person is approximately 3.15. As Table 3.9 shows, the transportation modeling process indicates that each alternative has virtually the same mode split, with 58% of person trips belonging to the “drive alone” category, 41% in multiple-occupancy private vehicles, and the remaining 1% via other modes such as transit, walk and bicycle. However, a detailed review of transit usage (see Table 3.15) shows that the Infill scenario experiences the highest level of boardings, with 56% more daily boardings than the Suburban scenario.

The average year 2050 trip length for work trips and for all trips is reported in Table 3.10. In each case, the average trip is shortest for the Infill alternative and longest under the Base Case. The Suburban scenario has slightly greater average trip lengths than the Activity Center concept.

Table 3.8
Daily Person Trips – Year 2050

| Statistic | Base Case | Infill | Activity Center | Suburban |
|------------------|------------------|---------------|------------------------|-----------------|
| Total Trips* | 28,957 | 28,743 | 28,982 | 28,951 |
| Trips per Person | 3.16 | 3.14 | 3.16 | 3.15 |

*Reported in thousands.
Source: MAG 2050 HSTATS.

Table 3.9
Mode Split of Daily Person Trips – Year 2050

| Mode | Base Case | Infill | Activity Center | Suburban |
|-------------|------------------|---------------|------------------------|-----------------|
| Drive alone | 58% | 58% | 58% | 58% |
| Drive group | 41% | 41% | 41% | 41% |
| Transit | 1% | 1% | 1% | 1% |
| Walk | <1% | <1% | <1% | <1% |
| Bicycle | <1% | <1% | <1% | <1% |

Source: MAG 2050 HSTATS.

Table 3.10
Average Trip Length (Miles) – Year 2050

| Type of Trip | Base Case | Infill | Activity Center | Suburban |
|---------------------|------------------|---------------|------------------------|-----------------|
| Work | 18.3 | 17.2 | 18.0 | 18.1 |
| All | 10.5 | 9.8 | 10.1 | 10.3 |

Source: MAG 2050 HSTATS.

3.3.3 Roadway Congestion and Transportation System Performance

Table 3.11 reports the number of freeway and arterial lane miles in the year 2050. (“Expressways” are included in the arterial category throughout this chapter.) Since each scenario has been modeled with the same regional roadway network, the number of lane miles is constant. The assumed transportation system has slightly more than three freeway lane miles for every ten arterial lane miles. Each scenario has approximately three lane miles of freeways and arterials per 1,000 residents of the MAG region. Because of definitional differences, the arterial mileage figures are not consistent with Table 2.3. However, the freeway mileage per 1,000 residents (0.65) is similar to levels in San Diego and Seattle today (see Table 2.3).

Table 3.11 also shows the percentage of severely congested freeway lane miles during the 2050 PM peak period. “Severe congestion” means a volume/capacity (V/C) ratio greater than 1.00, representing a demand volume higher than the capacity of the facility. The Base Case has the highest percentage of severely congested lane miles, with the Suburban scenario slightly lower than Infill and Activity Center.

Table 3.11
Roadway Lane Miles – Year 2050

| Lane Miles by Facility Type | Base Case | Infill | Activity Center | Suburban |
|--|------------------|---------------|------------------------|-----------------|
| Freeways | 5,939 | 5,939 | 5,939 | 5,939 |
| Arterials | 20,636 | 20,636 | 20,636 | 20,636 |
| Combined | 26,575 | 26,575 | 26,575 | 26,575 |
| Lane Miles per 1,000 persons | 2.9 | 2.9 | 2.9 | 2.9 |
| Severely Congested Freeway Lane Miles in PM Peak—total and % | 2,040—34% | 1,752—30% | 1,819—31% | 1,683—28% |

Source: MAG 2050 HSTATS.

Table 3.12 presents daily and PM peak vehicle miles of travel (VMT) for the regional freeway and arterial systems. Total daily and PM peak VMT are lowest for the Infill Scenario and highest for the Base Case. The VMT of the Suburban scenario is somewhat lower than that of the Base Case, but higher than in the Activity Center scenario. On a daily basis, freeways experience about 5% more VMT under the Base Case than the other three scenarios, with Suburban having the lowest VMT. A similar pattern exists during the PM peak, although the Infill rather than the Suburban scenario has the lowest VMT. On the arterial system, however, the Suburban is at or near the top in daily and PM peak VMT. This suggests that new or expanded arterials near the urban periphery receive the greatest usage with land development oriented toward the outlying areas. The Base Case experiences relatively high VMT on arterials as well as freeways. Total (freeway plus arterial) VMT per person ranges from 30.5 to 32.8 on a daily basis, and from 6.4 to 7.0 during the PM peak. The Infill scenario consistently has the lowest or close to the lowest VMT on both freeways and arterials.

Table 3.12
Vehicle Miles of Travel – Year 2050

| Daily VMT by Facility Type | Base Case | Infill | Activity Center | Suburban |
|--|------------------|---------------|------------------------|-----------------|
| Freeways* | 154,007 | 146,306 | 147,543 | 145,430 |
| Arterials* | 146,910 | 133,064 | 137,935 | 151,074 |
| Combined* | 300,917 | 279,370 | 285,478 | 296,503 |
| Combined VMT per person | 32.8 | 30.5 | 31.1 | 32.2 |
| Combined VMT per lane mile | 11,300 | 10,500 | 10,700 | 11,200 |
| Freeway VMT as % of total | 51.2% | 52.4% | 51.7% | 49.1% |
| PM Peak VMT by Facility Type | Base Case | Infill | Activity Center | Suburban |
| Freeways* | 27,185 | 25,916 | 26,209 | 26,122 |
| Arterials* | 36,613 | 32,303 | 33,857 | 36,208 |
| Combined* | 63,798 | 58,219 | 60,066 | 62,330 |
| Combined VMT per person | 7.0 | 6.4 | 6.6 | 6.8 |
| Severely Congested Freeway VMT in PM Peak—total* and % | 12,644—47% | 10,644—41% | 11,129—42% | 9,974—38% |

*Reported in thousands.
Source: MAG 2050 HSTATS.

Severely congested freeway VMT during the peak appears in the last line of Table 3.12. The Base Case has the highest percent and Suburban the lowest. The Suburban scenario appears to relieve pressure on the freeway system by generating suburb-to-suburb commute trips, which tend to be less freeway-focused than long trips to and from the center city. Both the Infill and Activity Center scenarios have lower percentages than the Base Case with respect to this measure.

Two measures of PM peak period freeway traffic congestion—congested lane miles and congested VMT—were highlighted in Tables 3.11 and 3.12. Table 3.13 reports a third such measure: PM peak traffic delay on the freeway system. The Suburban alternative has half the total delay of the Base Case. Similarly, PM peak traffic delay per person is lowest (6 minutes) in the Suburban scenario, and highest (12 minutes) in the Base Case. The Infill scenario has about two-thirds the delay of the Base Case, and the Activity Center scenario has nearly 80% as much delay as the Base Case.

Table 3.13
PM Peak Freeway Traffic Delay – Year 2050

| Characteristic | Base Case | Infill | Activity Center | Suburban |
|------------------------------|------------------|---------------|------------------------|-----------------|
| Total (thousands of hours) | 1,833 | 1,262 | 1,437 | 918 |
| Hours per person | 0.20 | 0.14 | 0.16 | 0.10 |
| Hours of Delay per 1,000 VMT | 67 | 49 | 55 | 35 |

Source: MAG 2050 HSTATS.

Table 3.14 shows the number and percentage of congested major intersections during the PM peak hour. Because signalized intersections are the bottlenecks that constrain arterial capacity, intersection congestion has been selected as the most accurate measure of surface street performance. The Suburban scenario has the lowest percentage of congested intersections (35%) and the Base Case has the highest (43%). The two intermediate alternatives, Infill and Activity Center, perform closer to the Suburban than the Base Case.

Table 3.14
Congested Intersections – PM Peak Hour (Year 2050)

| Measurement | Base Case | Infill | Activity Center | Suburban |
|---------------------------------------|------------------|---------------|------------------------|-----------------|
| Number of Congested Intersections | 1,112 | 972 | 989 | 901 |
| Congested Intersections as % of Total | 43% | 37% | 38% | 35% |

Source: MAG 2050 HSTATS.

Basic transit service and performance measures are listed in Table 3.15. Because the same level of transit service was assumed for each growth scenario, the number of vehicle revenue miles stays constant at 408,000 per weekday. The amount of transit usage, however, differs substantially by alternative. The 446,000 daily boardings under the Infill alternative are 56% more than projected for the Suburban scenario, 32% more than the Base Case and 20% more than the Activity Center scenario. The number of boardings per revenue mile, a key measure of transit service effectiveness, follows a similar pattern, with Infill having the highest and Suburban the lowest.

Table 3.15
Weekday Transit Service and Usage – Year 2050

| Measurement | Base Case | Infill | Activity Center | Suburban |
|-----------------------------|-----------|--------|-----------------|----------|
| Daily Boardings* | 337 | 446 | 371 | 286 |
| Vehicle Revenue Miles* | 408 | 408 | 408 | 408 |
| Boardings/Revenue Mile | 0.8 | 1.1 | 0.9 | 0.7 |
| Boardings/1,000 persons | 37 | 49 | 41 | 31 |
| Revenue Miles/1,000 persons | 45 | 45 | 45 | 44 |

*Reported in thousands.

Source: MAG 2050 HSTATS.

3.3.4 Roadway System Performance by Geographic Location

Tables 3.16 and 3.17 list the amount and percentage of congested freeway VMT (3.16), and hours of delay (3.17) in the 2050 PM peak, by Geographic Location. The amount and percentage of congestion vary greatly from one GL to another, and some GLs show greater variation in congestion across alternatives than others. Delay and severe congestion in 2050 will be most prevalent in four GLs: North, Northeast, NW/SW and the Central Area, which will remain the most congested (and most densely populated) part of the region even as congestion spreads to other areas. PM peak hour congestion and delay will continue to affect relatively few freeway miles in the Northwest, Southeast and (in some alternatives) Pinal County GLs.

Table 3.16
Severely Congested Freeway Lane Miles by Geographic Location – Year 2050

| Geographic Location | Lane Miles Experiencing Severe Congestion in PM Peak (Total/%) | | | |
|---------------------|--|---------|-----------------|----------|
| | Base Case | Infill | Activity Center | Suburban |
| Northwest | 0/0% | 0/0% | 0/0% | 9/23% |
| North | 234/39% | 181/30% | 207/35% | 191/32% |
| Northeast | 210/46% | 207/45% | 204/45% | 178/39% |
| NW/SW | 365/49% | 269/36% | 277/37% | 315/42% |
| Central Area | 977/39% | 804/32% | 883/35% | 723/29% |
| Southeast | 12/2% | 21/3% | 14/2% | 11/2% |
| Southwest | 159/17% | 99/11% | 154/17% | 243/26% |
| Pinal County | 79/15% | 21/4% | 80/15% | 10/2% |

Source: MAG 2050 HSTATS.

Similarly, Table 3.18 breaks down the number and percentage of congested intersections (during the PM peak) by GL. The Suburban scenario, which ranks highest for the region as a whole (Table 3.13), also performs best in six of the eight GLs. The Northwest and Southwest GLs are notable exceptions, however; in these areas the Infill alternative has the fewest congested intersections, probably because of sparse development in these more remote areas of Maricopa County.

Table 3.17
Freeway Traffic Delay by Geographic Location – Year 2050

| Geographic Locations | PM Peak Period Delay (thousands of hours) | | | |
|----------------------|---|--------|-----------------|----------|
| | Base Case | Infill | Activity Center | Suburban |
| Northwest | 1 | 0 | 1 | 4 |
| North | 294 | 180 | 237 | 150 |
| Northeast | 172 | 136 | 140 | 80 |
| NW/SW | 400 | 237 | 279 | 209 |
| Central Area | 758 | 601 | 592 | 315 |
| Southeast | 12 | 14 | 14 | 11 |
| Southwest | 170 | 73 | 122 | 141 |
| Pinal County | 27 | 22 | 22 | 9 |

Source: MAG 2050 HSTATS.

Table 3.18
Number of Congested Intersections by Geographic Location – Year 2050

| Geographic Location | Number of Congested Intersections in PM Peak (total/%) | | | |
|---------------------|--|---------|-----------------|----------|
| | Base Case | Infill | Activity Center | Suburban |
| Northwest | 67/29% | 9/4% | 25/11% | 114/49% |
| North | 99/55% | 81/45% | 93/51% | 75/41% |
| Northeast | 80/44% | 71/39% | 68/37% | 58/32% |
| NW/SW | 219/79% | 179/64% | 198/71% | 156/56% |
| Central Area | 513/50% | 515/51% | 478/47% | 327/32% |
| Southeast | 41/10% | 46/11% | 44/11% | 42/10% |
| Southwest | 78/34% | 55/24% | 68/30% | 115/51% |
| Pinal County | 15/19% | 16/20% | 15/19% | 14/18% |

Source: MAG 2050 HSTATS.

3.3.5 Roadway System Performance of Specific Routes

In addition to the comparison of growth scenarios on the basis of systemwide data and by GL, specific major highway routes were evaluated. MAG produced working graphics of the 2050 traffic volumes on the freeways and major expressways. The graphics display the volumes in thousands of vehicles per day by direction of travel. Four ranges of volumes were displayed by color code: 0 to 49; 50 to 99; 100 to 199; and 200 to 309. The upper end of the last range indicates the highest volume recorded in the traffic model runs.

In evaluating and comparing the four growth scenarios, the first two ranges were ignored because it was assumed that by 2050 all the major facilities potentially could be built or upgraded to accommodate up to 100,000 vehicles per day in each direction. The evaluation concentrated on highlighting the differences among the four growth scenarios on facilities projected to carry more than 100,000 vehicles per day per direction.

The volume to capacity ratios were also reviewed as a supplement to and validation of the evaluation performed on the traffic volumes. Less emphasis was placed upon the V/C ratios, because the capacities of the facilities used in the model run do not necessarily reflect an intent or ability to provide that capacity on a facility. As discussed previously, substantial capacity was added to many of the routes in anticipation of high volume projections for 2050. There was concern that if the capacities were too far below the projected volumes, either the traffic model would not be able to run to completion or the volumes would be reassigned outside of their reasonable desire lines in search of adequate capacity. As a result, the V/C ratios were used only as validation of the traffic volume analyses.

The evaluation consisted primarily of identifying road segments on which the assigned traffic volume differed among the four growth scenarios. In general, the Base Case and Activity Center scenario produced similar traffic volumes. The Suburban scenario generally had the results that differed the most from those of the other scenarios. In some cases, the Infill scenario also produced different results.

With the Suburban scenario, the traffic volumes in 2050 were projected to be lower than with the other three scenarios on the following routes:

- SR 101L
- I-17 from I-10 to SR 303L
- SR 51 from I-10 to SR 101L
- SR 202L from I-10 to Pecos Road (West Leg)

The lower volumes on these key routes in the center of the metropolitan area may be significant in the future. Accommodation of higher volumes on these routes will likely be more difficult and expensive than on routes on the periphery of the urban area.

With the Suburban scenario, the traffic volumes in 2050 are projected to be higher than with the other three scenarios on the following routes in the West Valley:

- Sun Valley Parkway
- SR 303L from I-10 to Bell Road
- I-10 from Sun Valley Parkway to SR 303L

This analysis indicates that the Suburban growth scenario would spread out future population growth and somewhat reduce the need for extensive new roadway construction in the more central part of the urban area. On the other hand, much of this additional growth is projected to occur in the far West Valley. The road system will need to be enhanced significantly to handle the traffic from the additional growth.

With the Infill Scenario, the traffic volumes in 2050 are projected to be lower than with the other three growth scenarios on the following road sections in the far West Valley:

- SR 303L from I-10 to Bell Road
- SR 85 from I-8 to I-10
- I-10 from Sun Valley Parkway to SR 303L

In contrast, with the Infill Scenario, the 2050 traffic volumes are projected to be higher than with the other three growth scenarios on the following road sections:

- SR 101L from I-10 to Northern Avenue
- SR 51 from I-10 to Shea Boulevard
- SR 202L from I-10 to Pecos Road

It is apparent that the Suburban and the Infill scenarios produce opposite results: i.e., Suburban would have more traffic in the far West Valley and less traffic in the central portion of the urban area. Almost no differences among the four growth scenarios were identified in the Southeast Valley.

3.4 *Transportation Insights*

Four alternative growth concepts were defined and analyzed in the preceding sections. The analysis was based upon a constant transportation system. This system represents the existing MAG Long Range Transportation Plan for 2025 plus additions to this system to serve the larger urban area that will exist when the region houses over 9 million people. The MAG model expanded the transit system to serve the larger area and enlarged the freeway system to accommodate more lanes of traffic needed for this large population level.

This analysis provides an indication of the interaction of each of the four growth concepts with the transportation system. Customization of the transportation system for each growth concept undoubtedly would improve the performance and efficiency of the transportation system associated with each concept. This would also improve the comparisons of the four scenarios. Such analysis, however, is beyond the scope of this project. It is important to recognize that the potential for variation of the transportation system, especially the roadway network, is somewhat limited because of the vast system that already exists and the limitations to new transportation corridors due to existing developments. As a result, large variations in the transportation system by growth concept are not likely. On this basis, the conclusions presented herein are believed to offer insight into each growth concept from a transportation perspective.

Table 3.19 defines performance measures designed to gauge how well each scenario meets the MAG goals and objectives presented in a previous task report. From one to three performance measures are associated with each objective under Goals 1 through 3, except Objective 3A which cannot be evaluated quantitatively. Some measures have been used more than once—e.g., daily transit passenger miles and daily boardings per 1,000 residents for Objectives 2D and 2E.

3.4.1 *Suburban Growth Concept*

The Suburban growth concept is characterized by continued outward spread of the metropolitan area at current densities, with employment and commercial activities scattered throughout the area. The analyses indicate that this concept would result in the least traffic congestion and the least transit usage. Suburban Growth would tend to require construction of the most miles of new freeways and arterials to serve the geographically larger urban area.

This growth concept is the most similar to the pattern of growth that has occurred in the Greater Phoenix area over the past several decades. This pattern promotes the spread of relatively affordable single-family detached housing, which appears to be a highly attractive option in the housing market. The pattern can also provide opportunities for short work and shopping trips, if a favorable jobs/housing balance is maintained and residents choose to live near work and to shop near home.

Table 3.19
Summary of System Performance Measures Versus Goals and Objectives by Alternative

| Goals/Objectives | Performance Measure(s) | Alternative Growth Scenarios – Evaluation Results Year 2050 | | | |
|---|--|--|-------------|------------------|-------------|
| | | Base Case | Infill | Activity Centers | Suburban |
| Goal 1: Maintenance & Safety | | | | | |
| 1A: Provide for the continuing maintenance needs of transportation facilities and services in the region, eliminating maintenance backlogs. | (Minimize) Daily VMT/lane mile | 11,300 | 10,500 | 10,700 | 11,200 |
| 1B: Provide a safe and secure environment for the traveling public, addressing roadway hazards and incident response, pedestrian and bicycle safety and transit security. | i. (Maximize) Percent of regional VMT on freeways | 51% | 52% | 52% | 49% |
| | ii. (Minimize) Percent severely congested freeway lane miles—PM peak | 34% | 30% | 31% | 28% |
| | iii. (Minimize) Percent congested intersections—PM peak | 43% | 37% | 38% | 35% |
| Goal 2: Access & Mobility | | | | | |
| 2A: Maintain an acceptable and reliable level of service on the transportation systems serving the region, taking into account performance by mode and facility type. | i. (Minimize) Daily hours of delay on freeway system—PM peak | 1.8 million | 1.3 million | 1.4 million | 0.9 million |
| | ii. (Minimize) LOS F freeway VMT as % of total freeway VMT—PM peak | 47% | 41% | 42% | 38% |
| | iii. (Minimize) Percent congested intersections—PM peak | 43% | 37% | 38% | 35% |
| 2B: Provide residents of the region with access to jobs, shopping, educational, cultural and recreational opportunities and provide employers with reasonable access to the workforce in the region | (Minimize) Average work trip length | 18.3 miles | 17.2 miles | 18.0 miles | 18.1 miles |

Table 3.19 (continued)

| Goals/Objectives | Performance Measure(s) | Alternative Growth Scenarios – Evaluation Results Year 2050 | | | |
|--|---|--|-------------|------------------|-------------|
| | | Base Case | Infill | Activity Centers | Suburban |
| 2C: Maintain a reasonable and reliable travel time for moving freight into, through and within the region, as well as provide high-quality access between intercity freight transportation corridors and freight terminal locations, including airport cargo facilities. | i. (Minimize) Percent severely congested freeway lane miles—PM peak | 34% | 30% | 31% | 28% |
| | ii. (Minimize) Percent congested intersections—PM peak | 43% | 37% | 38% | 35% |
| 2D: Provide the people of the region with mobility options necessary to carry out their essential daily activities and support equitable access to the region's opportunities. | (Maximize) Daily transit boardings | 337,000 | 446,000 | 371,000 | 286,000 |
| 2E: Address the mobility needs of the elderly and Title VI and Environmental Justice populations and avoid or mitigate adverse or disproportionately high impacts of transportation projects on these groups. | (Maximize) Daily transit boardings | 337,000 | 446,000 | 371,000 | 286,000 |
| Goal 3: Sustain the Environment | | | | | |
| 3B: Encourage programs, projects and land use planning that reduce: dependence on single occupant vehicles, the number of trips per household, and trip lengths. | i. (Minimize) Percent of trips by single-occupant vehicle | 58% | 58% | 58% | 58% |
| | ii. (Minimize) Average person trip length | 10.5 miles | 9.8 miles | 10.1 miles | 10.3 miles |
| 3C: Make transportation decisions that are compatible with air-quality conformity and water quality objectives, the sustainable preservation of key regional ecosystems and support a high quality of life. | i. (Minimize) Daily VMT | 301 million | 279 million | 285 million | 297 million |
| | ii. (Minimize) Daily hours of delay on freeway system—PM peak | 1.8 million | 1.3 million | 1.4 million | 0.9 million |
| | iii. (Minimize) Percent congested intersections—PM peak | 43% | 37% | 38% | 35% |

Source: MAG 2050 HSTATS, September 2002.

With this growth concept, however, people may tend to choose housing locations on the basis of price, amenities or proximity to friends and relatives. Most trips must be made via automobiles, which enable residents to access jobs and other destinations throughout the metropolitan area. VMT per capita would rise as the urbanized area expands and people have more choices of destination. The viability of this concept therefore depends on the provision and continuous expansion of a comprehensive regional freeway and arterial system.

This growth concept may provide the least opportunity to create unique urban environments. It also creates the greatest likelihood that older central residential areas will deteriorate and not be replaced by new housing or restored and maintained as viable residential communities. The tendency exists to move to newer areas and leave the old behind

This concept is relatively easy to implement because it is generally similar to what has occurred in the past. For some jurisdictions, no major change in policy or direction is required to achieve this growth pattern.

3.4.2 Infill Growth Concept

The Infill growth concept is characterized by full use and revitalization of the existing developed areas and a greater concentration of employment in established employment centers such as downtown areas and large industrial areas. This concept would result in the least outward spread of the urban area.

The Infill scenario would result in the most transit usage and the second lowest congestion on the highway system. However, it would require substantial upgrading of the existing freeway system beyond any current plans or expectations. Such extensive upgrading would be very expensive, especially in the built-up areas within the Inner Loop (SR 101). As noted in Section 3.3.5 above, this growth concept generally results in the highest traffic volumes on freeways in the central part of the metropolitan area.

Due to the greater densities and concentration of employment, transit would be more effective than with other growth concepts, and there would be greater opportunities to use the full range of transit and non-motorized modes. Rail transit would be a major component of the transportation system, providing opportunities for dense mixed-use nodes near transit stations. This growth concept provides a high opportunity to develop unique urban environments and to provide a viable alternative transportation system that is not almost exclusively dependent upon the automobile. Therefore, this growth scenario would likely do well at meeting the mobility needs of an increasingly diverse and aging population, including those who lack their own vehicle, cannot drive or prefer not to do so.

The Infill concept would be the most difficult to implement because its full realization would require substantial change in laws and policies that govern development and the relationships among local jurisdictions. Implementation strategies such as urban growth boundaries and economic policies that change the relative cost of auto versus transit use may be needed. Such strategies could lead to higher housing costs.

3.4.3 Activity Center Concept

The Activity Center concept is characterized by the presence of several mixed-use, higher-density nodes within the metropolitan area that serve as focal points for employment and commercial activity and offer unique urban environments. These activity centers may have varying sizes, but all need to emphasize transit and non-motorized modes for internal circulation. These centers need transit as well as highway

connections to the surrounding areas and the entire metropolitan area. Downtown Tempe is emerging as an example of a mixed-use activity center, despite fairly difficult roadway access.

With properly designed and economically successful centers, some vehicle trips will be eliminated and average trip lengths may be reduced. The size and location of the centers needs to be carefully coordinated with the highway and transit system to avoid concentrating congestion and to enable the centers to be economically successful.

The Activity Center concept, like the Infill concept, does not necessarily mesh well with the existing and planned street, freeway or transit system. Except in downtowns with denser street networks, the major roadway system is primarily a uniform grid that does not provide the transportation focus needed to support transit-oriented activity centers. Downtown Phoenix and downtown Tempe/ASU are perhaps the only locations where there is a convergence of freeway and transit service and sufficient density of major land uses to support a large activity center. Other downtowns such as in Mesa, Scottsdale, Glendale, and Chandler currently lack sufficient transit service (and some lack freeway service) to provide the transportation advantages of major activity centers. This could change in the future, however, with extension of the regional high-capacity transit system to serve these downtowns. The residential portion of the activity mix may be particularly challenging in older activity centers given the age of the housing stock, quality of public schools and other socioeconomic factors. Outside the traditional downtowns, master planned developments in the greater Phoenix area tend to spatially separate land uses and offer an uncongenial environment for transit service.

Establishment of activity centers within existing developed areas is challenging. Residents of adjacent neighborhoods often resist increasing density to the point needed to support activity centers. The constraints of existing development and infrastructure reduce the potential for activity center development. Given supportive public policy, however, construction of a new fixed guideway transit system can be a sufficient trigger to allow activity center development around stations. In addition, the general plans of several cities contain provisions for future development organized around activity centers.

Newly developing or planned activity centers in suburban locations need to have a level of arterial and highway access that makes them more attractive for employment and commercial activity than other areas. The planned activity centers need a sufficiently dense network of streets to avoid the concentration of traffic at a few major intersections that simply cannot handle the traffic needs of a fully developed center. The density of the activity center needs to be adequate to promote walking and bicycle trips within it. Much like traditional downtown areas, the activity center needs to be a focal point for transit service, so that circulator transit systems can relieve some of the burden on local streets in the area.

3.4.4 Base Case Concept

The Base Case concept represents the combination of existing general plans of all the local jurisdictions in the metropolitan area. These plans reflect existing development trends and reflect visions and desires of the individual communities. When the Base Case is tested against the planned transportation system plus a continuation of that system beyond the current planning horizon, the analyses indicate that this concept had the most congestion of the four scenarios tested. Although general plans are developed in concert with transportation plans, these plans often must attempt to reconcile conflicting views of how best to accommodate future growth. Also, the general plan of any one community is not necessarily consistent with those of adjacent jurisdictions. These factors may have contributed to the higher levels of congestion.

The results of these analyses indicate that a more coordinated regional approach in the preparation of general plans could benefit the transportation system in the region. Elements that could be focused on include the following: more cooperation between adjacent cities to plan compatible land uses; improvement in the balance of residents and employment in each subregion regardless of jurisdiction; avoidance of excessive concentrations of employment activities where the transportation system cannot support them; and avoidance of new large growth areas that cannot be adequately served by a feasible transportation system.

Table 3.20 summarizes some major advantages and disadvantages of each long-range growth concept.

Table 3.20
Key Advantages and Disadvantages of Alternative Growth Concepts

| Concept | Advantages | Disadvantages |
|--------------------------|--|--|
| Suburban | <ul style="list-style-type: none"> ▪ Generally results in the least roadway congestion ▪ Easy to implement—similar to existing development patterns ▪ Enables market to maximize moderate-cost single family housing ▪ Allows people to choose housing near (suburban) workplaces | <ul style="list-style-type: none"> ▪ Not conducive to effective transit service or usage ▪ Maximizes the need to extend roadway networks ▪ Tends to result in higher overall VMT ▪ Associated with negative impacts of sprawl and urban blight |
| Infill | <ul style="list-style-type: none"> ▪ Maximizes use and effectiveness of transit and non-motorized modes ▪ Results in less overall roadway congestion than Activity Center or Base Case ▪ Promotes development of unique urban environments ▪ Improves mobility options more than any other concept | <ul style="list-style-type: none"> ▪ Difficult to implement given current development patterns and government structure ▪ Requires substantial investments in improving existing central-area roads ▪ May tend to raise housing costs in the region |
| Activity Center | <ul style="list-style-type: none"> ▪ Envisioned in the general plans of several MAG member jurisdictions ▪ Helps to meet the demand for unique urban places ▪ True mixed-use centers tend to reduce VMT and trip lengths ▪ Lends itself to effective external (regional) and internal transit | <ul style="list-style-type: none"> ▪ Results in more roadway congestion than other alternatives, except base case ▪ Few existing examples in MAG region ▪ Requires significant policy changes, though less than Infill |
| Base Case (General Plan) | <ul style="list-style-type: none"> ▪ Allows jurisdictions to follow existing plans and policies ▪ More controlled and orderly growth than with Suburban concept | <ul style="list-style-type: none"> ▪ Results in the highest levels of roadway congestion ▪ Does little to restrain growth in VMT |

4.0 LONG RANGE TRANSPORTATION SYSTEM NEEDS

In Chapter 3, a greatly expanded future (year 2050) transportation system was assumed in order to analyze transportation effects of the alternative growth scenarios. In Chapter 4, future needs are assessed in relation to the current plans for roadway and transit systems. Information from recent MAG model runs, the MAG Long Range Transportation Plan (LRTP), and the Federal Transit Administration's National Transit Database is applied to the assessment of long-range transportation needs. Roadway needs are assessed in Section 4.1 and transit needs in Section 4.2. Because of inherent differences between the two modes and the types of data used to measure system size and performance, different methods are used to evaluate regional roadway and transit needs.

4.1 Future Roadway System Needs

In this section, long-range needs are discussed for the two types of roadways that carry over 80% of peak hour VMT: freeways and arterials (with expressways categorized as arterials). The number of lane miles per 1,000 residents is used to measure the supply of both freeways and arterials in relation to demand. Two direct measures of PM peak hour congestion are also considered: congested freeway lane miles as a percent of the regional total freeway lane miles, and congested arterial lane miles as a percent of the regional total arterial lane miles. "Congestion" is defined in this chapter as Level of Service E or worse; i.e., a volume/capacity ratio greater than 0.90. This differs from the "severe congestion," defined as Level of Service F (v/c ratio greater than 1.00), used in Chapter 3 to compare the performance of freeways under alternative growth scenarios. It also differs from the TTI definition of congestion used in Chapter 2.

MAG provided a series of new model runs to its consultant in December 2002. The peak hour runs used in this analysis were labeled "2000 automatic w/2041 zones 12/03/02," "2020 Update SocEc Draft 2-2020," and so on for the years 2030 and 2040. All of these model runs use the regional roadway network described in the MAG LRTP 2002 Update, along with updated socioeconomic projections for the years 2010, 2020, 2030 and 2040.

As Table 4.1 shows, the LRTP network represents a marked increase in the size of the regional roadway system, with 60% more freeway lane miles and 91% more arterial lane miles than in the year 2000. Section 3.2.1 of this report contains a description of major freeway and arterial system improvements in the LRTP.

Table 4.1
Number of Roadway Lane Miles: Existing Year 2000 Versus LRTP Network

| Roadway Type | Year 2000 Lane Miles | Future Lane Miles | Percent Increase |
|-----------------------------------|----------------------|-------------------|------------------|
| Freeways | 1,993 | 3,197 | 60% |
| Arterials (including expressways) | 10,814 | 20,690 | 91% |

Source: MAG Model Update, December 2000.

Table 4.2 reports model-generated estimates for the years 2000, 2020, 2030 and 2040 for the following roadway system characteristics in the MAG region:

- Freeway lane miles per 1,000 population
- Percent of freeway lane miles experiencing congestion in the PM peak hour

- Arterial lane miles per 1,000 population
- Percent of arterial lane miles experiencing congestion in the PM peak

All of the values shown in Table 4.2 for the years 2020, 2030 and 2040 are based on the LRTP roadway network, which is targeted for the year 2022.

The regional population is projected to grow by 69% from 2000 to 2020, and by 41% from 2020 to 2040. As a result, the number of freeway lane miles per 1,000 persons would decline by approximately one-third (from 0.64 to 0.43) between 2000 to 2040. The number of arterial lane miles per 1,000 persons would decrease by approximately one-fifth (from 3.49 to 2.81) during this period. During the same 40-year period, the percent of congested lane miles in the PM peak would increase by a factor of roughly 1.50 for freeways and 2.4 for arterials.

The potential criteria in Table 4.3 are numerical ranges whose boundaries are defined by the year 2000 and 2020 conditions of the roadway system. For freeways, the upper bound is 0.64 lane miles per 1,000 residents (year 2000) and the lower bound is 0.61 (year 2020). For arterials, the upper bound is 3.96 (year 2020) and the lower bound is 3.49 (year 2000). The upper and lower limits of these ranges are intended to approximate a reasonable range of freeway and arterial service in the MAG region.

Table 4.3 also incorporates the assumption that the prevalence of freeway congestion reflects the number of freeway lane miles per capita, while the prevalence of arterial congestion reflects the number of arterial lane miles per capita. For example, the range of 0.61 to 0.64 freeway lane miles per 1,000 persons corresponds to a range of 15% to 21% of the freeway system experiencing congestion during the PM peak, on the basis of the 2000 and 2020 data in Table 4.2. Similarly, a range of 3.49 to 3.96 arterial lane miles per 1,000 persons corresponds to approximately 10% of arterial lane miles experiencing congestion in the PM peak.

Having established these criteria for the freeway and arterial systems, it is now possible to approximate the number of additional lane miles required in subsequent years (2030, 2040 and beyond) to bring the total size of each system within the specified range, given the projected regional population. Table 4.4 shows the number of additional freeway lane miles (beyond those in the MAG LRTP network) needed in the years 2030, 2040 and 2050. The calculations for 2050 assume a regional population of 9.17 million, as presented in the “Base Case” growth scenario (Chapter 3). To keep pace with population growth, the regional freeway system specified in the LRTP would require considerable expansion from 2020 to 2030. Even larger increases in lane miles would be required from 2030 to 2040, and from 2040 to 2050.

Table 4.5 applies similar reasoning to show the number of additional arterial lane miles needed, beyond those in the LRTP network, to provide an adequate regional system after 2020. As with the freeway system, additional expansion of the system would be required during each decade from 2020 to 2050.

The required geographic distribution of these additional lane miles will depend on the location and density of regional growth over the next 50 years. Under the Infill or Activity Center scenario (Chapter 3), many of the necessary lane miles would consist of additional lanes on existing facilities, particularly inside the SR 101 loop. Under the Base Case or Suburban Growth scenario, many of the additional lane miles would be constructed in newly urbanizing areas on the fringe of the region.

Table 4.2
Selected MAG Freeway and Arterial System Characteristics, 2000-2040

| Year | Population | Freeways | | Arterials (including expressways) | |
|------|--------------|--------------------------|--------------------------------------|-----------------------------------|--------------------------------------|
| | | Lane Miles per 1,000 Pop | % of Lane Miles Congested* (PM Peak) | Lane Miles per 1,000 Pop | % of Lane Miles Congested* (PM Peak) |
| 2000 | 3.10 million | 0.64 | 15% | 3.49 | 10% |
| 2020 | 5.23 million | 0.61** | 21% | 3.96** | 10% |
| 2030 | 6.30 million | 0.51** | 31% | 3.28** | 22% |
| 2040 | 7.36 million | 0.43** | 38% | 2.81** | 34% |

*Level of Service E or F (volume/capacity ratio > 0.90).

**With MAG LRTP roadway network in place.

Sources: MAG "Total Population by MPA," revised December 2002; MAG PM peak hour model runs, "2000 automatic w/2041 zones 12/03/02," "2020 Update SocEc Draft 2-2020," "2030 Update SocEc Draft 2-2030," "2040 Update SocEc Draft 2-2040."

Table 4.3
Potential Criteria for Extent and Performance of MAG Freeway and Arterial System

| Roadway Characteristic | Objective |
|--|-----------|
| Freeway Lane Miles per 1,000 Population | 0.61-0.64 |
| Percent of Freeway Lane Miles Congested (PM Peak) | 15%-21% |
| Arterial Lane Miles per 1,000 Population | 3.49-3.96 |
| Percent of Arterial Lane Miles Congested (PM Peak) | 10% |

Table 4.4
Future Year Requirements to Meet Freeway System Objectives

| Year | Additional Freeway Lane Miles Required | | | | Resulting Lane Miles per Resident | Estimated % Congested (PM Peak)* |
|--------|--|----------|--|----------|-----------------------------------|----------------------------------|
| | Total | | % Increase over Lane Miles in LRTP Network | | | |
| | Range | Midpoint | Range | Midpoint | | |
| 2030 | 646-835 | 741 | 20%-26% | 23% | 0.61-0.64 (Table 4.3) | 15%-21% (Table 4.3) |
| 2040 | 1,293-1,513 | 1,403 | 40%-47% | 44% | 0.61-0.64 (Table 4.3) | 15%-21% (Table 4.3) |
| 2050** | 2,397-2,672 | 2,535 | 75%-84% | 79% | 0.61-0.64 (Table 4.3) | 15%-21% (Table 4.3) |

*Based on the simplifying assumption that the percent of freeway lane miles congested in the PM peak is a function of freeway lane miles per capita.

**Based on projected 2050 population of 9.17 million in Base Case Growth Scenario (Chapter 3).

Table 4.5
Future Year Requirements to Meet Arterial System Objectives

| Year | Additional Arterial Lane Miles Required | | | | Resulting Lane Miles per Resident | Estimated % Congested (PM Peak)* |
|--------|---|----------|--|----------|-----------------------------------|----------------------------------|
| | Total | | % Increase over Lane Miles in LRTP Network | | | |
| | Range | Midpoint | Range | Midpoint | | |
| 2030 | 1,297-4,258 | 2,778 | 6%-21% | 13% | 3.49-3.96 (see Table 4.3) | 10% (see Table 4.3) |
| 2040 | 4,996-8,456 | 6,726 | 24%-41% | 33% | 3.49-3.96 (see Table 4.3) | 10% (see Table 4.3) |
| 2050** | 11,313-15,623 | 13,468 | 55%-76% | 65% | 3.49-3.96 (see Table 4.3) | 10% (see Table 4.3) |

*Based on the simplifying assumption that the percent of arterial lane miles congested in the PM peak is a function of arterial lane miles per capita.

**Based on projected 2050 population of 9.17 million in Base Case Growth Scenario (Chapter 3).

4.2 Future Transit System Needs

4.2.1 Overview

In this section, long-range transit needs are addressed by comparing existing and future service in the MAG region with today's service in two metropolitan areas: Chicago and Los Angeles. The Chicago metro area's current population is very close to the assumed 2050 MAG total of 9.17 million (under the Base Case growth scenario from Chapter 3), while the Los Angeles metro population is 79% larger at 16.37 million. Each region has, or will have, two main types of transit service: conventional bus and fixed guideway. The latter consists primarily of urban and commuter rail but could also include bus rapid transit service using dedicated busways or bus lanes.

Table 4.6 lists the existing (year 2000) values of two key indicators of the amount of transit service provided in the Los Angeles, Chicago, and Phoenix urban areas. These indicators are the vehicle revenue miles of transit service per year, and the route miles (linear right-of-way miles) of fixed guideway. A transit vehicle consists of one bus or one rail car. Chicago has a large heavy rail (subway/elevated) system, Los Angeles has both heavy and light rail, and both cities have extensive commuter rail networks—although the Chicago system operates a far greater number of trains. Phoenix currently has no fixed guideway transit. The current population figures are U.S. Census Bureau 2000 totals for each metropolitan area.

Table 4.6 also shows the estimated transit vehicle revenue miles, and miles of fixed guideway, in the MAG region in 2022, according to the most recent (2002) LRTP Update. The fixed guideway network consists of the planned 39-mile light rail system serving Phoenix, Glendale, Tempe and Mesa. Annual bus revenue miles were calculated by tripling the existing amount of local bus service and quadrupling express bus service, as specified in the LRTP. Annual vehicle revenue miles of rail service were estimated by applying the existing number of revenue miles per route mile from the two existing light rail lines in greater Los Angeles.

Table 4.6
Vehicle Revenue Miles of Service and Miles of Fixed Guideway, by Urban Area and Year

| Urban Area and Year | Population (millions) | Vehicle Revenue Miles of Service/Year (Thousands) | | | Right-of-Way Miles of Fixed Guideway | | |
|---------------------|-----------------------|---|----------------|---------|--------------------------------------|---------------|-------|
| | | Bus | Fixed Guideway | Total | Heavy or Light Rail | Commuter Rail | Total |
| Los Angeles 2000 | 16.37 | 169,100 | 14,600 | 183,700 | 57 | 385 | 442 |
| Chicago 2000 | 9.16 | 99,400 | 94,400 | 193,800 | 103 | 560 | 663 |
| Phoenix 2000 | 3.10 | 26,000 | 0 | 26,000 | 0 | 0 | 0 |
| Phoenix 2022 (LRTP) | 5.44 | 79,200* | 4,400** | 83,600 | 39 | 0 | 39 |

*Based on tripling of local bus service (96% of today's weekday service) and quadrupling of express service (4%).

**Estimated from existing ratio of vehicle revenue miles to system length, for light rail (Blue and Green lines) in Los Angeles area.

Sources: MAG and FTA National Transit Database for 2000. FTA provides data on "directional route miles," which are assumed to equal twice the right-of-way miles for a predominantly two-track system.

4.2.2 Bus Service Needs

Table 4.7 compares existing (year 2000) vehicle revenue miles of bus service per 1,000 residents. Metropolitan Los Angeles and Chicago now have roughly 23% to 29% more bus service per resident than the Phoenix area. The table also shows regional bus service per capita in the MAG region for the years

2022 (based on the LRTP Update) and 2050. The 2050 figure assumes a population of 9.17 million and no added service after 2022. Under this transit service scenario, Phoenix moves ahead of today's bus service levels in the other two cities by 2022, but again lags behind by 2050.

Table 4.7
Comparison of Regional Bus Service Per 1,000 Residents

| Urban Area and Year | Metro Area Population | Annual Vehicle Revenue Miles of Service per 1,000 Residents |
|---|-----------------------|---|
| Los Angeles 2000 | 16.37 million | 10,300 |
| Chicago 2000 | 9.16 million | 10,800 |
| Phoenix 2000 | 3.10 million | 8,400 |
| Phoenix 2022 <i>(with LRTP transit system)*</i> | 5.44 million | 14,600 |
| Phoenix 2050 <i>(with 2022 LRTP transit system)</i> | 9.17 million | 8,600 |

*2022 MAG population estimate obtained by linear interpolation between 2020 and 2030 forecasts (see Table 4.2 above).
Source: FTA National Transit Database for 2000, MAG and U.S. Census 2000.

Table 4.8 shows the amount of additional bus service that would be needed to bring the amount of Phoenix-area bus service per capita in 2050 up to the level currently available in Chicago or Los Angeles. The number of revenue miles in the 2025 LRTP system would have to be increased by 26% to provide a year 2050 service level comparable to what Chicago has today, or by 20% to match the current service per capita in Los Angeles. Total service in Phoenix would have to increase from 79,000 revenue miles in the year 2022 to approximately 95,000 by 2050 to match the current level of bus service in Los Angeles, or 99,000 to match the current level in Chicago.

Table 4.8
Additional Bus Service Required in Phoenix Urban Area 2050 to Match Other Cities' Year 2000 Levels

| Comparison Urban Area | Thousands of Annual Revenue Miles of Bus Service Required to Match (Los Angeles or Chicago) Service Level Per Capita | |
|-----------------------|--|------------------------------|
| | Additional MAG-Region Bus Service | Total MAG-Region Bus Service |
| Los Angeles 2000 | 15,600 (20% increase) | 94,800 |
| Chicago 2000 | 20,200 (26% increase) | 99,400 |

4.2.3 Fixed Guideway Service Needs

Table 4.9 shows the current level of urban (light plus heavy) and commuter rail service per capita in Los Angeles and Chicago. The Chicago area boasts more than ten times as much rail service per capita as Los Angeles, even though it has just 50% more route miles. With the currently planned 39-mile light rail system in place, the Phoenix area in 2022 would have nearly as much rail service per resident as greater Los Angeles does today. Without additional fixed guideway routes by 2050, however, vehicle revenue miles per capita would fall from approximately 800 to 500. Additional fixed guideway routes would be needed to equal or exceed the year 2000 intensity of service in the Los Angeles area.

Table 4.9
Comparison of Regional Fixed Guideway Transit Service Per 1,000 Residents

| Urban Area and Year | Annual Vehicle Revenue Miles of Service per 1,000 Residents | | |
|--|--|---------------|--------|
| | Light + Heavy Rail | Commuter Rail | Total |
| Los Angeles 2000 | 500 | 400 | 900 |
| Chicago 2000 | 6,000 | 4,200 | 10,200 |
| Phoenix 2022—with planned LRTP transit system | 800 | 0 | 800 |
| Phoenix 2050—with planned 2022 LRTP transit system | 500 | 0 | 500 |

Source: National Transit Database for 2000.

Table 4.10 lists ten generalized corridors—above and beyond the planned 39-mile system—that may be suitable for light rail and/or busway rapid transit within the next 50 years. The majority of these corridors are illustrated in the Executive Summary of the Draft MAG LRTP Update for 2002. Some corridors would further extend the Central Phoenix/East Valley LRT line, some would connect to it, and a few would replace or enhance the BRT service that the City of Phoenix will implement in selected corridors beginning in 2003. One peripheral corridor, along SR 101 connecting the Arrowhead, I-17/Deer Valley, Desert Ridge and Scottsdale Road/SR 101 regional activity centers, is also included. Overall, these ten potential corridors would add 129 miles to the regional fixed guideway network, thereby more than quadrupling the currently planned 39-mile system.

Table 4.11 lists potential commuter rail routes that could initiate service by 2050. These five routes—the BNSF northwest line, the UP east and west lines, and the UP Tempe and Chandler branches—total approximately 102 right-of-way miles. Annual vehicle revenue miles of commuter rail service were estimated by applying the existing number of revenue miles per route mile from the Los Angeles Metrolink system. (Chicago’s Metra commuter rail system operates extensive off-peak and weekend service on many routes; a Phoenix-area system is expected to more closely resemble Metrolink in focusing on peak period trips.)

If all of the potential rail/busway corridors listed in Table 4.10 are implemented, with an intensity of service similar to that of Los Angeles’s existing light rail systems, then greater Phoenix by 2050 will have approximately 2,100 annual vehicle revenue miles of urban fixed guideway service per 1,000 residents. Similarly, if commuter rail operates on all the potential routes listed in Table 4.11, Phoenix will have approximately 200 annual vehicle revenue miles of such service per 1,000 residents. The MAG regional total of 2,300 would be nearly 2.5 times as high as the existing level of 900 in Los Angeles, but little more than one-fifth of the current 10,200 in Chicago (Table 4.9).

The comparative analysis of fixed guideway transit suggests that even with large-scale transit investment, the MAG region will remain much more reliant than Chicago on private automobile transportation, and hence will require more freeway and other roadway miles per capita. On the other hand, an ambitious long-term investment program will enable the MAG region to meet its transit needs more effectively than greater Los Angeles does today, as measured by the amount of service provided per 1,000 residents.

Table 4.10
Potential Year 2050 Extensions to MAG Urban Fixed Guideway Transit System

| LRT/BRT* Corridor | Length (Miles) | Remarks | |
|--|-----------------------|--|--|
| I-17, Metrocenter to Loop 101 | 5 | Northern extension of planned Metrocenter LRT branch. | |
| SR 51, Central/Camelback area to SR 101 | 16 | Connects with CP/EV—possible interline. | |
| South Central Avenue, Downtown Phoenix to Southern Avenue | 4 | Could replace City of Phoenix BRT. | |
| I-10, Downtown Phoenix to Litchfield Road | 18 | Could use bus station at Central/I-10. | |
| I-10, Downtown Phoenix to Chandler Boulevard | 18 | Could use bus station at Central/I-10. | |
| Arizona Avenue, Southern Avenue to Chandler Boulevard | 6 | Extension from east end of CP/EV. Subject to change based on Chandler MIS now in progress. | |
| Main Street (Mesa), Mesa Drive to Superstition Springs Mall | 10 | Extension from east end of CP/EV. | |
| Scottsdale/Rural Road, SR 101 to Elliot Road | 22 | Would interline with CP/EV in or near Downtown Tempe. | |
| Grand Avenue/83 rd Avenue, Downtown Glendale-Arrowhead Towne Center | 8 | Extension of planned Glendale LRT branch. | |
| SR 101, Scottsdale Road-Arrowhead Towne Center | 22 | Peripheral connector. | |
| LRT/BRT Totals | Length (Miles) | Estimated Vehicle Revenue Miles/Year | |
| | | Total (000) | Per 1,000 Residents (year 2050) |
| <i>All LRT/BRT Extensions (beyond 39-mile planned LRT system)</i> | <i>129</i> | <i>14,600</i> | <i>1,600</i> |
| <i>Entire LRT/BRT System</i> | <i>168</i> | <i>19,000</i> | <i>2,100</i> |

Note: corridors are not listed in order of importance or merit.

*In this column, "BRT" refers to a high-capacity system providing all-day service in dedicated lanes, not part-time service on freeway (or arterial) HOV lanes shared with other vehicles.

Source: MAG LRTP 2002 Update Executive Summary (May 2002 Draft).

Table 4.11
Potential Year 2050 MAG Commuter Rail System

| Commuter Rail Corridor | Length (Miles) | Remarks | |
|--|-----------------------|---|--|
| BNSF RR, Downtown Phoenix to SR 303 | 26 | BNSF northwest line. | |
| Union Pacific RR, Downtown Phoenix to Williams Gateway | 29 | UP east line. | |
| Union Pacific RR, Downtown Phoenix to Buckeye | 31 | UP west line. | |
| UP Tempe Branch, Downtown Tempe to Chandler Boulevard | 8 | Commuter rail branch. | |
| UP Chandler Branch, Baseline Road to Queen Creek Road | 8 | Commuter rail branch. | |
| Total | Length (miles) | Estimated Vehicle Revenue Miles/Year | |
| | | Total (000) | Per 1,000 Residents (year 2050) |
| <i>Commuter Rail System</i> | <i>102</i> | <i>1,700*</i> | <i>200</i> |

Note: corridors are not listed in order of importance or merit.

*Estimated from existing ratio of vehicle revenue miles to directional route miles, for commuter rail system (Metrolink) in Los Angeles area.

The comparative analysis of fixed guideway transit suggests that even with large-scale transit investment, the MAG region will remain much more reliant than Chicago on private automobile transportation, and hence will require more freeway and other roadway miles per capita. On the other hand, an ambitious long-term investment program will enable the MAG region to meet its transit needs more effectively than greater Los Angeles does today, as measured by the amount of service provided per 1,000 residents.